



BRENT SPENCE  
BRIDGE CORRIDOR

Moving the Economy,  
Creating Jobs

BRENT SPENCE BRIDGE PROJECT  
**OPTIONS ANALYSIS**  
SEPTEMBER 2013



**HNTB**

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## EXECUTIVE SUMMARY

In July 2013, the State of Ohio and the Ohio Department of Transportation (“ODOT”) in conjunction with the Commonwealth of Kentucky and the Kentucky Transportation Cabinet (“KYTC”), together the “States” completed this Options Analysis to assess the quantitative and qualitative merits of potential project models to deliver the Brent Spence Bridge Project (“Project”).

Through this Study, the States have explored whether alternate delivery options are appropriate for the Project, while still obtaining the overall project goals of 1) improving traffic flow and the level of service, 2) improving safety, 3) correcting geometric deficiencies, and 4) maintaining connections to key regional and national transportation corridors.

Federal funding assistance is currently limited and expected to remain limited in the future. At existing funding levels constructing the project would absorb both states’ entire major new funding capacity for a period of approximately four years. Therefore, alternative delivery and funding options, including tolling, are necessary to ensure this project, which is important to local residents, commuters, businesses and interstate commerce is built in the foreseeable future.

The Options Analysis initially considered four primary delivery alternatives: 1) Design-Bid-Build; 2) Design-Build (DB); 3) Availability Payment Concession; and 4) Toll Revenue Concession. For both qualitative and quantitative reasons, ODOT and KYTC chose to eliminate the Design-Bid-Build alternative in favor of the cost and schedule benefits proven to be available through a Design-Build public delivery model. Similarly, following a market sounding exercise suggesting little market appetite as well as a high level quantitative analysis suggesting that toll revenues would not generate sufficient equity return to make a toll concession attractive to industry without a significant public subsidy, the full toll revenue concession alternative was eliminated. Therefore, the discussion within this Options Analysis focuses primarily on the Design-Build and Availability Payment Concession delivery models, considered by the States to represent the most attractive potential options.

A comparison of the two options is shown in **Table ES-1**. Both presented are viable options that will be further evaluated by the States during the next several months.



**Table ES-1: Comparison of Design-Build and Availability Payment Concession Options**

ITEM	DESIGN-BUILD	AVAILABILITY PAYMENT CONCESSION
Capital Work Delivery Mechanism	The States would invite competitive proposals to design and build all of the Capital Work (bundled) under a firm price arrangement. Under the DB arrangement the private entity would not be responsible for O&M.	The States would invite competitive proposals to design, build, and finance all of the Capital Work (bundled) under a firm price arrangement. Under the DBFOM arrangement the private entity would also operate and maintain the entire project scope (including the newly built capital maintenance portion and the existing bridge) from the Substantial Completion date to the end of the Term.
Procurement and Award	Best Value award with minimal post-award negotiation.	Best Value award with minimal post-award negotiation.
Funding Sources for Capital Work	Public allocation of funds (Note these sources of funding are very limited as compared to the needs).	Public allocation of funds (Note these sources of funding are very limited as compared to the needs).
Financing sources for Capital Work	From the States' financing options, including toll revenue bonds, subject to budgetary considerations and available federal sources	From a combination of: (a) equity; (b) commercial debt (that may include tax-exempt debt); (c) available federal financing;
Evaluation Period	55-year evaluation period comprised of a: <ul style="list-style-type: none"> <li>• 5-year construction period ending in December 2018; and</li> <li>• 50-year operations period from January 2019.</li> </ul>	55-year evaluation period comprised of a: <ul style="list-style-type: none"> <li>• 5-year construction period ending in December 2018;</li> <li>• 35-year operating period beginning in January 2019 (together with the 5-year construction period the "concession period"); and</li> <li>• 15-year net cash flow (revenue, O&amp;M and lifecycle costs) forecasted beyond the end of the concession period.</li> </ul>

## CONSTRUCTION, OPERATIONS & MAINTENANCE AND LIFECYCLE COSTS

Given the need for funding, the project team first focused on identifying ways to reduce the project cost, while maintaining the functionality agreed upon as part of the Environmental Assessment, approved in March of 2012. A workshop held in October of 2012 considered alternative technical concepts to the preferred Alternative I. The following configuration updates are expected to generate real (in 2012 dollars) project cost savings of \$150M:

- Reduction in main span pier spacing from 1000' to 870' (approval received from the Coast Guard in January 2013);

- Use of network (instead of inclined) tied arch bridges for navigation span only; and
- Use of narrower shoulders (outside shoulders were reduced from 14' to 12' and inside shoulders were reduced from 14' to 8').

The option that incorporates each of these refinements is referred to as Alternative I-A. Present value operations and maintenance costs for Alternative I-A are projected at \$470M. Lifecycle costs are projected at \$240M.

## TRAFFIC & REVENUE

The traffic and revenue analysis estimated total toll revenue the states can expect to be available to meet the project's future obligations. Two traffic and revenue scenarios were developed based on a series of assumptions that include:

- A \$1 base toll for autos; a \$3 charge for light trucks; and \$5 charge for heavy trucks;
- A \$2 base toll for autos; a \$6 charge for light trucks and a \$10 charge for heavy trucks;
- All vehicles are assumed to pay a 50% premium for video processing;
- Transponder penetration rates on opening day are assumed at 50% for autos and 65% for heavy trucks, increasing to 70% for autos and 85% for heavy trucks by 2028; and
- The majority of the vehicles that are expected to divert would travel to the Daniel Carter Beard and Clay Wade Bailey Bridge river crossings.

Traffic counts indicate that the Brent Spence Bridge traffic has been in the 150,000 to 160,000 vehicles per day range for the past decade. The results of the preliminary traffic and revenue analysis indicate that:

- Diversion for the \$1 base toll scenario is projected at 25% opening day, but anticipated to drop over time to 17%.
- Diversion for the \$2 base toll scenario is projected at 39% opening day, but anticipated to drop over time to 27%.

## RISK ANALYSIS

The cost of risks for the design build and P3 options for the Project were quantified using a hybrid approach:

1. Individually quantified risks: 88 specific quantifiable risks were identified and assigned to the owner (public sector) or contractor/concessionaire (private sector) during workshops that took place in January and March of 2013.
2. Innovation and Efficiency Savings: During a May 2013 meeting KYTC and ODOT leaders agreed that, depending on the specific incentives and terms of a Design-Build contract, that certain risk adjustments might be appropriate to reflect any changed terms during the project delivery period. Such risks are reflected in this Options Analysis through the addition of a risk premium to the Design-Build alternative ranging from 5% to 15%, depending on specific terms expected to be incorporated into the agreement. This range, and the specific commercial terms expected to be incorporated into a Design-Build contract, will be the subject of further assessment in the next study phase.

## PRELIMINARY ANALYSIS

The quantitative analysis estimates the value of the full lifecycle costs of each delivery model for a common evaluation period. The key metrics in this analysis are the public subsidy during Project development, the public subsidy during operations, and the net project value.

- **Design-Build Model consideration:** Under all scenarios, the preliminary analysis of the DB Model indicates a requirement for a public subsidy during Project development. Should the States choose to deliver the Project via a DB Model, they should consider availability of these funds during the Project's development period. No public subsidy is required during the Project's operations phase.
- **Availability Payment Model consideration:** The AP Model, by definition, does not require a public subsidy during Project development since all costs are rolled into the Availability Payment, effectively amortizing these over the life of the concession. A public subsidy will however be required in the early stages of the Project's operations phase. In the short-term, funding will be required to cover the shortfall between Availability Payments and net toll revenues, which may be provided through public funds, public debt or short-term toll increases. Availability payments exceed net toll revenues in the short term; however, toll revenues exceed Availability Payments for most of the Project's duration. On a net present value basis, assuming the \$2 toll scenario and TIFIA credit assistance, toll revenues from the Project would be sufficient (in total) to fund the assumed 35 years of Availability Payments, when such revenues are considered over the full 55-year analysis horizon.
- **Net Project Value consideration:** The net Project value for the Design-Build model assumes that a public subsidy is contributed during the construction period. Once completed, excess cash flow is projected relatively early in the evaluation period, based on the direct benefits of the construction period subsidy. This timing difference accounts for a sizeable portion of the net Project value benefit relative to the Availability Payment model.

It should be emphasized that the findings from this analysis are indicative only, and based on a range of preliminary cost inputs that result in a range of outputs under each delivery model. The impact of TIFIA credit assistance has been assessed and would have a material effect on the net project value, to the extent that assistance is not secured through the application process. Inputs to each of the models should be refined by the States and the Project Team during the next stage of analysis. Together with a comprehensive Qualitative Assessment, such refinements to the Quantitative Analysis should then provide the basis for a bi-State consensus view of preferred Project delivery approach.

## QUALITATIVE CONSIDERATIONS

In addition to the preliminary Quantitative Analysis, a comprehensive Options Analysis should also reflect an equally important range of Qualitative Considerations. Such considerations, which will be further explored during the next phase of the study, should include:

- **Experience of similar project delivery** – the States' experiences with procuring and implementing specific delivery models for projects of similar scale and estimated cost to the Project is unprecedented and alignment of the goals of each State with the relative benefits of different delivery methods will be a key consideration;



- **Community and stakeholder positions on project related issues** – level of support or resistance from third parties (community groups, cities, businesses, residents, etc.) and how this plays out in the media and influences the States' ability to move forward should be more fully explored;
- **Procurement leadership** – the identification of senior leadership to drive the project and the availability of State staff or resources to procure and deliver the various contract options;
- **Expected private sector interest and participation** – the level of interest, under the right conditions, should drive an effective competition and help deliver value to the states;
- **Economic impact** – the benefit the region receives due to the improvement to this commerce corridor in comparison to the cost to the region of delaying transportation infrastructure improvement;
- **Scope Change Flexibility** – the ease with which desired changes to the scope can be carried out and the relative cost of doing so at various points in the process;
- **Budget Certainty** – the ability to be confident of the cost to owning, operating and maintaining the infrastructure during the analysis period;
- **Opportunity for innovation, cost reduction and/or risk transfer** – to varying degrees each delivery model may provide different opportunities to drive long-term value to the States and should be assessed;
- **Contract structure** – the relative complexity for each delivery method could impact the States' and industry's ability to successfully implement the contracts;
- **Federal commitments and interactions** – the ability to secure requisite project approvals from the federal government, including the ability to secure an unprecedented level of TIFIA assistance, are key considerations to the evaluation of delivery alternatives.
- **States' legislative, legal and policy frameworks** – Table ES-2 summarizes what additional authority is required by each state to move forward with the Project.

Table ES-2: Summary of States' Authorities

LEGISLATION	PURPOSE	KY	OH
<b>Tolling authority</b>	To allow the Project to be tolled.	Amendment needed to KRS 175B to include projects between Kentucky and Ohio.	Existing authority as part of: O.R.C. 5531.11 – 5531.99 (Toll facilities) O.R.C. 5501.70 – 5501.73 (P3 Facility)
<b>Toll violation enforcement</b>	For electronic tolling to be implemented	Amendment needed to KRS 175B to include projects between Kentucky and Ohio.	Authority needed as part of: O.R.C. 5531.15 (Toll facilities, amendment needed for video enforcement) O.R.C. 5501.77 (User fees on P3 facilities, amendment needed for video enforcement)
<b>DB authority</b>	For DB jobs over a certain dollar value	Current authority exists for up to 5 design build projects with a construction value of \$30M or less.	Existing authority as part of O.R.C. 5517.011, but currently capped at \$1 billion per fiscal year.
<b>P3 authority</b>	For state to procure P3 services	Amendment needed to KRS 175B to allow P3 option.	Existing authority as part of O.R.C. 5501.70 – 5501.80.

- **States' support and/or credit backstop** – the viability of securing and reliance on the relevant support from the States;
- **Whole life performance standards** – the degree to which the States define whole life performance requirements will drive long-term value; the States' ability and willingness to enforce such commitments and standards are also an important consideration;
- **Operational Control** – the level of control the states maintain over the facility will impact preferred delivery model;
- **Implementation of tolling** – the anticipated tolling approach, administration, policy (such as toll collection and rate setting) and back office operations will influence anticipated level of transaction and revenue and therefore the financial viability of each delivery model;
- **Toll revenue surpluses** – the potential for the extent to which the States share any toll revenue surpluses impacts the overall net project value and financial viability to each State;
- **Decision making process** – the ability and speed that each State, or a public body that has authority to act on behalf of the States, would require to make project and contract decisions should be explored and understood relative to each delivery model.

## NEXT STEPS

Next steps to advance the Project should include:

- Further consideration of qualitative issues of relevance within each State;
- Development of a more robust bi-State governance and Project oversight agreement;
- Initiation of a federal strategy to position the Project for key federal approvals, including environmental, tolling, TIFIA and other funding/financing issues;
- Consideration of project phasing and/or segmentation relative to each delivery model;
- Advancement of the environmental process/documentation effort, which is currently on the critical path;
- Development of more detailed schedule, funding and delivery model estimates for both the Design-Build and Availability Payment Concession delivery options;
- Further assessment of commercial structure alternatives;
- Initiation of toll concept and a schedule of alternative tolling/operating models;
- Refinement of Project inputs, including those inputs related to traffic, revenue, costs and financing;
- Further due diligence and potential refinements to the risk assumptions and innovation/efficiency savings under each delivery model;
- Continued public outreach and education of stakeholders; and
- Development of an approach to identifying and securing necessary state legislation.

## 1. PROJECT GOALS AND OBJECTIVES

### 1.1 STUDY OBJECTIVE

The State of Ohio, through the Ohio Department of Transportation (“ODOT”), in conjunction with the Commonwealth of Kentucky and the Kentucky Transportation Cabinet (“KYTC”), commissioned this Options Analysis to evaluate the use of various delivery options to deliver the Brent Spence Bridge Project (“Project”). The Study examines a range of scenarios to deliver the Project, ensuring that protecting the public interest is the overriding consideration at all times. A key objective of this Analysis is to foster understanding of each delivery method analyzed to inform future discussions.

#### 1.1.1 STUDY PARTICIPANTS AND ADMINISTRATION

The Study is being undertaken by a team of consultants (“Project Team”) under the direction of the Bi-State Management Team. The team is comprised of representatives from ODOT and KYTC. The Project Team is led by HNTB Ohio Inc. (“HNTB”), with support from KPMG Corporate Finance LLC (“KPMG”) as financial and commercial advisor, Steer Davies Gleave (“SDG”) as traffic and revenue forecasting advisor, and Wordsworth Communications (“Wordsworth”) as communications advisor.

#### 1.1.2 THE BI-STATE MANAGEMENT TEAM’S PROJECT GOALS

Through this Study, the Bi-State management Team and the Project Team have explored whether alternate delivery options are appropriate for the Project, while still obtaining the overall project goals of 1) improving traffic flow and the level of service, 2) improving safety, 3) correcting geometric deficiencies, and 4) maintaining connections to key regional and national transportation corridors. The study will examine traffic patterns and revenue estimates taking into consideration the willingness of customers to pay tolls and the potential for user charges to cause diversion of traffic to other facilities.

#### 1.1.3 PROJECT COSTS

A Federal Highway Administration (“FHWA”) Cost Estimate Workshop was conducted with FHWA, ODOT, and KYTC in the first quarter of 2012, which established a total Project cost estimate between \$2.5 billion and \$2.9 billion (under the assumption that Project costs would be incurred from 2014 to 2020). The States anticipate further activities under FHWA’s Cost Estimate Review (CER) process as the Project proceeds.

All references to dollar amounts in this Options Analysis are based on fiscal year, unless otherwise noted.

#### 1.1.4 CONSIDERATION OF ALTERNATIVE DELIVERY METHODS

**Table 1-1** summarizes what additional authority is required by each state to move forward with the Project. Kentucky has tolling authority, but not between Kentucky and Ohio. Both states need toll violation enforcement authority to be able to implement an all-electronic tolling system. Existing and needed design build and P3 authorities are also summarized in **Table 1-1**.

**Table 1-1: Additional Authority Required to Progress the Project**

LEGISLATION	PURPOSE	KY	OH
<b>Tolling authority</b>	To allow the bridge to be tolled	Amendment needed to KRS 175B to include projects between Kentucky and Ohio.	Existing authority as part of: <ul style="list-style-type: none"> <li>• O.R.C. 5531.11 - 5531.99 (Toll Facilities)</li> <li>• O.R.C. 5501.70 - 5501.73 (P3 Facility)</li> </ul>
<b>Toll violation enforcement</b>	For AET to be implemented	Amendment needed to KRS 175B to include projects between Kentucky and Ohio.	Authority needed as part of: <ul style="list-style-type: none"> <li>• O.R.C. 5531.15 (Toll facilities, amendment needed for video enforcement)</li> <li>• O.R.C. 5501.77 (User fees on P3 facilities, amendment needed for video enforcement)</li> </ul>
<b>DB authority</b>	For DB jobs over a certain dollar value	Current authority exists for up to 5 design build projects with a construction value of \$30M or less. For BSB special design build authority would be needed from the general assembly.	Existing authority as part of O.R.C. 5517.011, but currently capped at \$1 billion per fiscal year.
<b>P3 authority</b>	For state to procure P3 services	Amendment needed to KRS 175B to allow P3 option.	Existing authority as part of O.R.C. 5501.70 - 5501.80.



## 2. STATEMENT OF NEED

### 2.1 DESCRIPTION OF CURRENT BRIDGE CROSSING

The Brent Spence Bridge corridor consists of 7.8 total miles of I-75 located within portions of Ohio and Kentucky. Interstate 75 within the Greater Cincinnati/Northern Kentucky region is a major thoroughfare for local and regional mobility. Locally, it connects to I-71, I-74 and US 50. The Brent Spence Bridge provides an interstate connection over the Ohio River and carries both I-71 and I-75 traffic. The bridge facilitates local travel by providing access to downtown Cincinnati, Hamilton County, Ohio and Covington, Kenton County, Kentucky. Regionally, the I-75 corridor connects states from southern Florida to northern Michigan and is one of the busiest freight movement (trucking) routes in the United States<sup>1</sup>. Approximately \$417 billion in freight crosses the Brent Spence Bridge every year, which is equivalent to 3 percent of U.S. Gross Domestic Product<sup>2</sup>. This number is expected to almost double to \$830 billion by 2030. In addition, 75 percent of the jobs<sup>3</sup> in the region are located within five miles of I-75. As such, the Brent Spence Bridge corridor is an important link for the local, regional and national economies.

In spite of the corridor's importance to the nation and the region, congestion, safety, and geometric problems exist on the structure and its approaches<sup>4</sup>, as discussed below.

#### 2.1.1 CONGESTION

The Brent Spence Bridge, which opened to traffic in 1963, was designed to carry 80,000 vehicles per day<sup>5</sup>. Following are specific characteristics of the bridge:

- Approximately 143,000 to 167,000 vehicles used the bridge each day between 1999 and 2009<sup>6</sup>;
- Traffic volumes are projected to increase to approximately 248,750 vehicles per day by 2040<sup>7</sup>;
- Traffic congestion on the Brent Spence Bridge costs an average of 3.6 million hours of delay for passenger cars every year<sup>8</sup>; and
- Roughly 1.6 million gallons of fuel are wasted annually due to traffic congestion, which is projected to increase to 5.7 million gallons per year by 2030<sup>9</sup>.

<sup>1</sup>FHWA Expression of Interest regarding Tolling and Pricing Opportunities.

<sup>2</sup>Study by the Texas Transportation Institute (2009) commissioned by Representatives Geoff Davis and Steve Driehaus.

<sup>3</sup>The Ohio-Kentucky-Indiana Regional Council of Governments.

<sup>4</sup>Brent Spence Bridge Environmental Assessment (March, 2012).

<sup>5</sup>Brent Spence Bridge Environmental Assessment (March, 2012).

<sup>6</sup>Environmental approvals were based on approximately 172,000 vehicles per day.

<sup>7</sup>Environmental approvals were based on approximately 233,000 vehicles per day by 2035.

<sup>8</sup>Study by the Texas Transportation Institute (2009) commissioned by Representatives Geoff Davis and Steve Driehaus.

<sup>9</sup>FHWA Expression of Interest regarding Tolling and Pricing Opportunities.

### 2.1.2 SAFETY

Based on historical evidence, motorists are three times more likely to be involved in a traffic accident on the Brent Spence Bridge corridor than any other portion of the interstate system in Ohio and five times more likely to be involved in an accident than any other portion of the interstate system in Kentucky<sup>10</sup>.

### 2.1.3 GEOMETRY

The National Bridge inventory lists the bridge as functionally obsolete due to safety concerns, such as limited driver visibility, narrow lane width and lack of emergency lanes. In light of the issues discussed above, an important purpose of the Brent Spence Bridge Project is to improve the operational characteristics within the I-75 corridor for both local and through traffic.

## 2.2 DESCRIPTION OF LOCAL ACTIONS TAKEN TO ADDRESS INVESTMENT NEED

The project is a top priority of the Kentucky Transportation Cabinet (KYTC), the Ohio Department of Transportation (ODOT), the Ohio-Kentucky-Indiana Regional Council of Governments (OKI), the Northern Kentucky Chamber of Commerce, and the Cincinnati USA Regional Chamber of Commerce.

In August 2012, KYTC and ODOT completed a multi-year effort to develop alternative solutions to the project needs. Based on the results of engineering and environmental analysis, and extensive public involvement, KYTC and ODOT identified a preferred alternative for improving the Brent Spence Bridge corridor. The project is currently estimated to cost in excess of \$2.5 billion, making it the largest infrastructure project ever to be built in the region. It is also one of the largest transportation projects being considered in the United States.

However, public sources are currently insufficient to fund the improvements. The estimated project costs are approximately five times the State of Ohio and Commonwealth of Kentucky combined annual budgets for new and capacity-driven projects<sup>11</sup>, and dedication of funds to deliver the Project via traditional means in the near-term would heavily impact existing KYTC and ODOT programs.

Currently, KYTC and ODOT indicate that the Project could not be fully funded through traditional means until 2040. Until then, the congestion and safety problems on the bridge will continue to worsen, resulting in further losses due to vehicle delay and fuel consumption, which could compromise the economic vitality of the corridor. Furthermore, Project costs will continue to grow each year due to inflation and increases in material and labor costs.

Finding a viable financial and physical solution to replacing the Brent Spence Bridge prior to 2040 is imperative not only to the local area, but also the region and the national economy. This Options Analysis evaluates the DB Model and Alternative Delivery Models available to implement the new project.

<sup>10</sup>Information provided by the Ohio Department of Transportation and Kentucky Transportation Cabinet.

<sup>11</sup>Provided by ODOT and KYTC.

### 3. PROCESS OVERVIEW

#### 3.1 INTRODUCTION

Every project is unique and has a distinct risk profile. As a result, an objective methodology must be applied to understand these risks, their magnitude, and how the allocation of these risks varies between different procurement strategies. The goal is to evaluate how the value of the risks varies, and therefore how the risks are optimally allocated, among the various parties involved.

A critical aspect of any project delivery strategy is that it must be iterative and cannot be simply performed once at the outset of an assessment of delivery models. Market conditions can change rapidly, impacting the ability to finance a project. In addition, various policy concerns, risks, and financing issues may arise during the procurement process that will need to be assessed in terms of impact on value for the States.

#### 3.2 SUMMARY OF OPTIONS ANALYSIS PROCESS

The Options Analysis initially considered four primary delivery alternatives: 1) Design-Bid-Build; 2) Design-Build; 3) Availability Payment Concession; and 4) Toll Revenue Concession. For both qualitative and quantitative reasons, ODOT and KYTC chose to eliminate the Design-Bid-Build alternative in favor of the cost and schedule benefits proven to be available through a Design-Build public delivery model. In a similar fashion, the States chose to forgo the full Toll Revenue Concession, due to initial market sounding responses suggesting little market appetite, coupled with high level quantitative analysis suggesting that toll revenues would not be sufficient to generate positive cash flow and sufficient equity return to make such a concession attractive to industry without a significant public subsidy. Therefore, this initial Options Analysis focuses on the following two potential delivery models, considered by the States to represent the two most attractive potential options:

- **Design-Build (DB) Delivery Model:** The DB Model reflects the risk-adjusted, whole-life costs of a project procured via a design-build delivery approach. This model transfers specified design and construction risks to the private sector, while the public sector retains a variety of risks associated with project schedule, financing, operations, maintenance and lifecycle costs.
- **Availability Payment (DBFOM) Delivery Model:** As an alternative to the DB Model, the DBFOM Model involves a private partner assuming responsibility for the design, construction, financing, operation and maintenance of the Project over an evaluation period that is comparable to the DB Model. The public sector remains responsible for pledging a revenue stream to support the private financing, which may or may not be reimbursed with project tolls. These revenues are paid to the private partner in predetermined maximum annual installments, or 'Availability Payments', on the condition that the facility is available and meets agreed-upon performance specifications. Any failure to achieve such standards may result in reductions to the Availability Payment revenue stream.

As part of the Options Analysis, a financial model was used to quantitatively assess the net project value or cost of each potential delivery model for the Project. **Figure 3-1** represents the iterative process that has been undertaken in this preliminary evaluation process.

Figure 3-1: Assessing the Options



### 3.3 WORKSHOP STRUCTURE

#### 3.3.1 PRACTICAL DESIGN AND VALUE ENGINEERING WORKSHOP RESULTS

On October 17-19, 2012, the Project Team facilitated a Practical Design and Value Engineering Workshop with representatives from ODOT, KYTC, and FHWA. The primary objective of the workshop was to produce alternative technical concepts to the preferred Alternative I, to establish whether savings in Project costs or delivery schedule could be achieved with manageable incremental risk or other impacts. Numerous alternative concepts were evaluated. The most promising technical concepts, which were assumed when developing the cost assumptions detailed in **Section 4**, include:

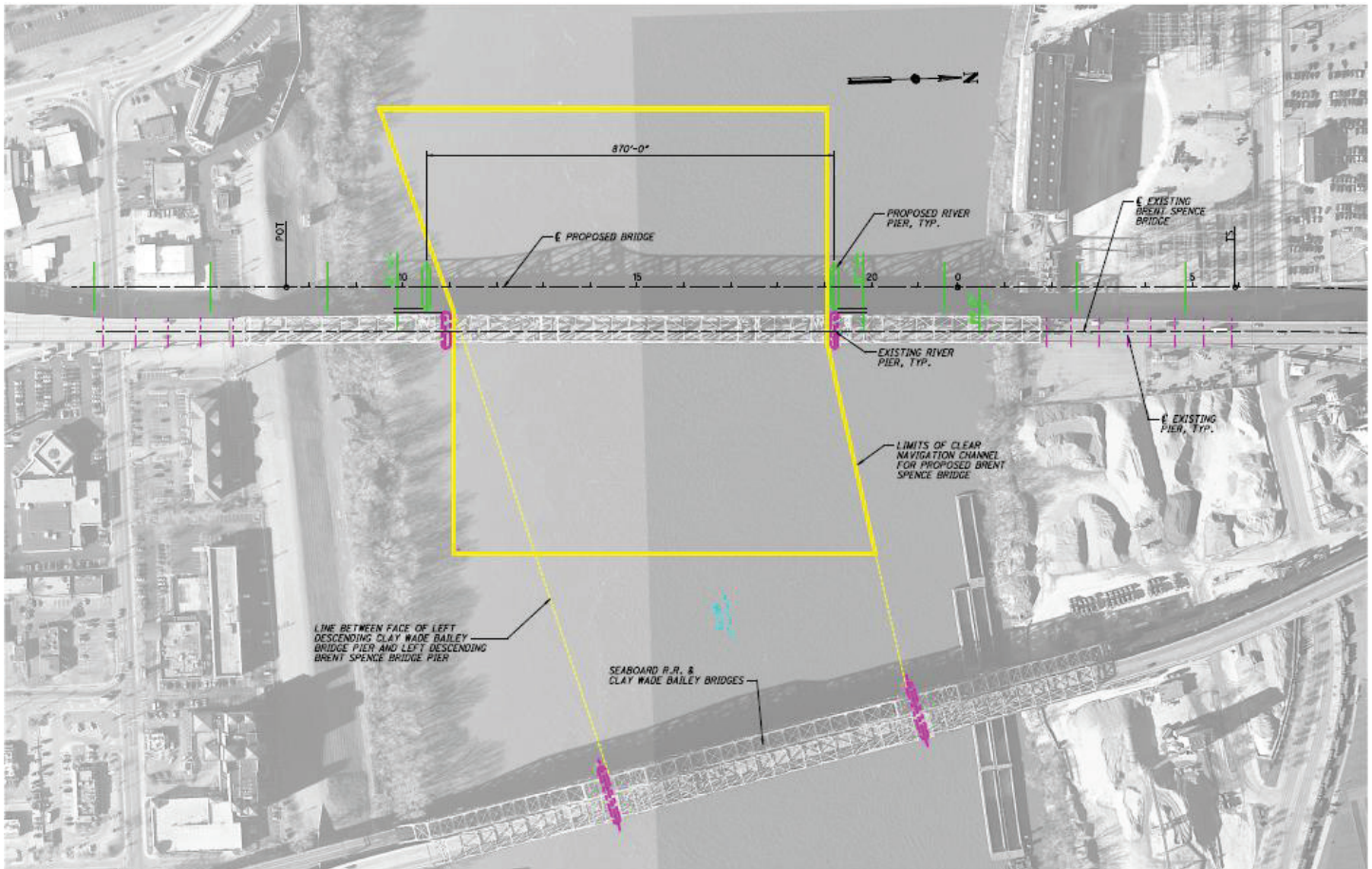
- Reduction in main span pier spacing from 1000' to 870';
- Use of network tied arch bridges for navigation span only; and
- Use of narrower shoulders.

The option that incorporates each of these refinements is referred to as Alternative I-A.

##### 3.3.1.1 Pier Spacing

In early January, 2013, the Project Team received written notification of approval from the United States Coast Guard in St. Louis and the navigation industry of revisions to the pier spacing. The revised pier locations are shown in **Figure 3-2**. Furthermore, a clear zone was specified on the drawing to allow the final design to have some flexibility in pier placement. The revised pier locations will shorten the main-span to 870-feet and could provide significant cost savings on the Project.

Figure 3-2: Clear Navigation Channel Limits

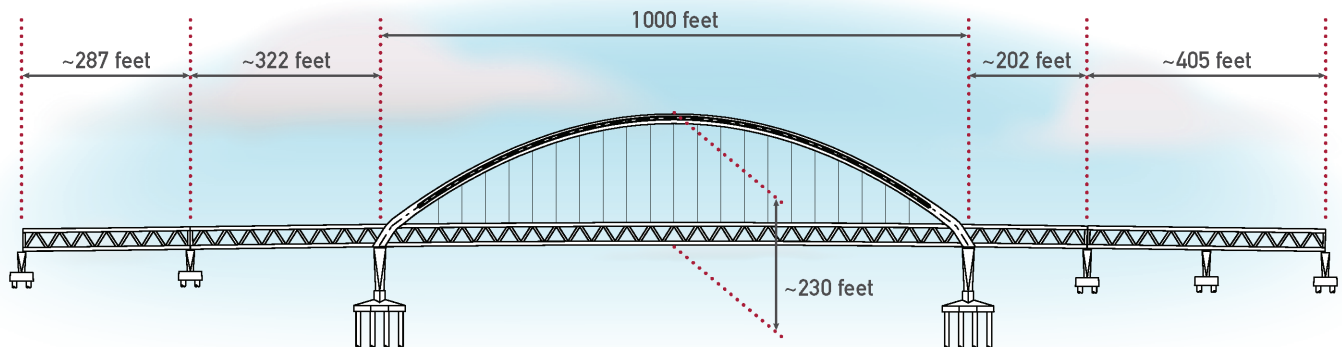




### 3.3.1.2 Bridge Type

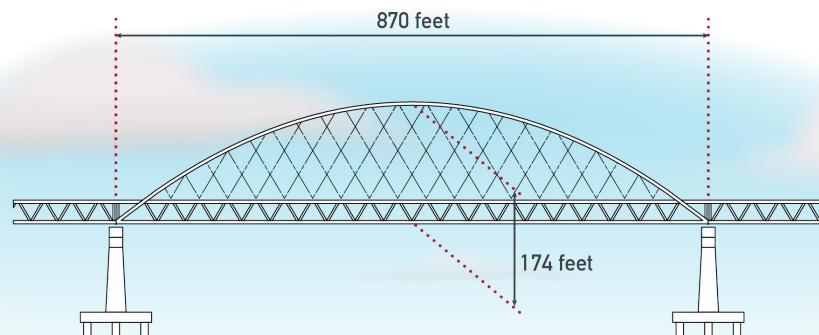
The Bridge Type Selection Report discussed three options for the main span; one single-tower cable-stay option, one dual-tower cable-stay option and an inclined tied arch bridge option. The inclined tied arch bridge option (based upon the original 1000' main span) is shown in **Figure 3-3**.

**Figure 3-3: Alternative I Profile – Inclined Tied Arch**



As a result of the Practical Design and Value Engineering Workshops and further analysis by the Project Team, a network tied arch with plumb ribs structure has been advanced in Alternative I-A (**Figure 3-4**). The advantages of this design are a more efficient hanger system and easier construction. The network hanger system provides greater redundancy to the arch rib and tie girder by spreading the hanger loads to adjacent sections (as opposed to the vertical hanger system). The use of plumb arch ribs instead of inclined allows the ribs to be fabricated with much simpler geometry and constructed more easily due to the lack of out of plane forces during erection.

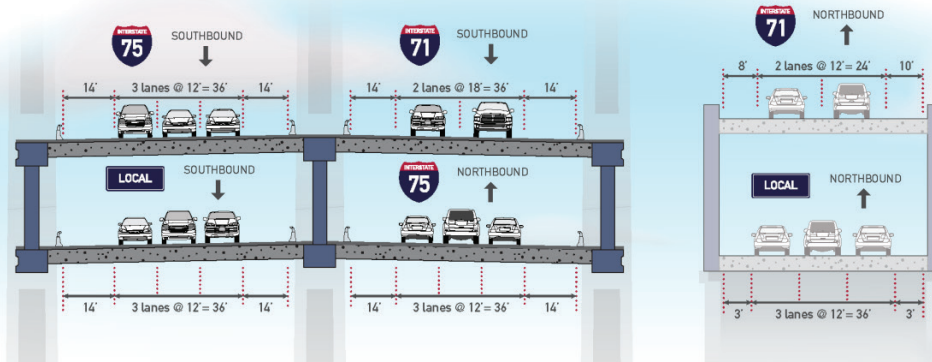
**Figure 3-4: Alternative I-A Profile – Network Tied Arch**



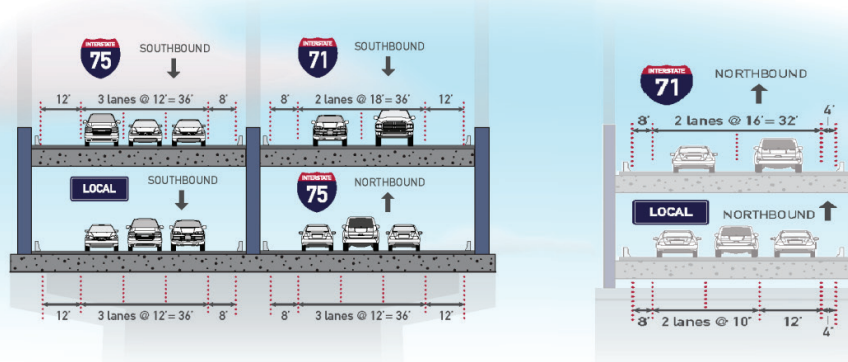
### 3.3.1.3 Replacement of Superstructure

Alternative I-A assumes rehabilitation of the existing Brent Spence Bridge deck during the construction phase. When developing lifecycle costs for Alternative I, replacement of the superstructure was assumed in year 50. In addition, Alternate I's original cross-section shown in **Figure 3-5** was modified. On the proposed Brent Spence Bridge, outside shoulders were reduced from 14' to 12' and inside shoulders were reduced from 14' to 8'. Again, this revised alternative is referred to as Alternative I-A in the cost estimates, and shown in **Figure 3-6**.

**Figure 3-5: Alternative I Cross-Section (utilizing existing Brent Spence Bridge superstructure)**



**Figure 3-6: Alternative I-A Cross-Section (utilizing existing Brent Spence Bridge superstructure)<sup>12</sup>**



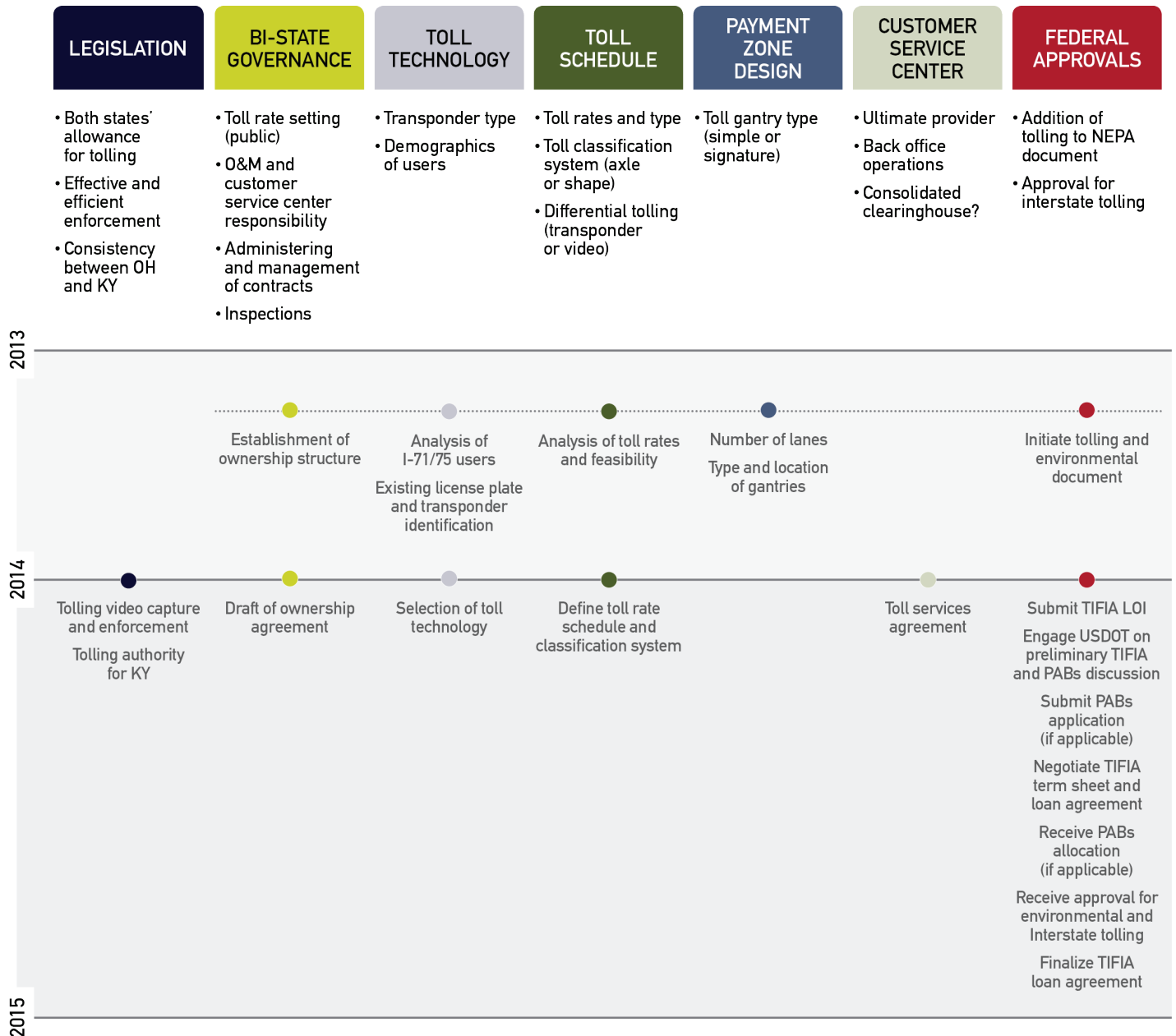
<sup>12</sup>Lane widths shown reflect the remainder of deck width after subtracting minimum requested shoulder widths from total deck width (controlled by lower roadway width). Actual lane widths should match approach lane widths with shoulder widths transitioning to and from max widths across span. The larger widths were shown in the cross section for simplicity, not requirement.

### 3.3.2 TOLLING WORKSHOP

On November 27, 2012, the Project Team facilitated a Tolling Workshop with representatives from ODOT, KYTC, OKI, and FHWA present at ODOT's District 8 offices. The Tolling Workshop was devised to address the key concepts and policy decisions associated with tolling in the corridor. The workshop also allowed key functional groups to agree on common assumptions to be used in development of the Options Analysis.

Many policy decisions need to be made early in the Project development process as they are critical inputs to capital and operating costs and revenue forecasts. While general assumptions can be made during the preliminary evaluation of a toll facility, more refined analysis requires a clearer understanding of the business rules. Additionally, the procurement documents for a project must include the operating details as defined by the policies and business rules. The major tolling policy issues introduced during the Workshop are summarized below in **Figure 3-7**.



Figure 3-7: Tolling Policy<sup>13</sup>

<sup>13</sup>Many toll policies and business rules will be developed on a parallel track with proposed legislation but all will be compliant with the final legislation.

### 3.3.3 FINANCIAL WORKSHOP

On December 18, 2012, the Project Team convened a half-day Financial Workshop with an objective of reaching consensus on the appropriate financial inputs to the Options Analysis. Participants included representatives from ODOT, KYTC and FHWA. The Workshop also served to:

- Introduce and discuss recent market precedents and comparable projects and transactions;
- Explore the range of potential delivery options for the Project (discussed more in **3.4.1**); and
- Agree on the financing inputs, assumptions and structure for the Project.

On May 29, 2013, the Project Team convened to review and reaffirm the financing inputs and assumptions to be adopted for the Options Analysis.

### 3.3.4 RISK WORKSHOP

The Project Team facilitated a Preliminary Risk Workshop on January 7, 2013, with the primary objective of identifying, qualifying and quantifying, at a high level, the risks associated with the Project. Participants included representatives from ODOT, KYTC and FHWA.

ODOT, KYTC and Parsons Brinckerhoff had previously developed a register of risks for the Project during the FHWA Cost Estimate Review. HNTB and KPMG expanded on this register by identifying additional risks based on previous experience. HNTB and KPMG presented this combined Risk Matrix during the Preliminary Risk Workshop, during which participants:

- Assessed the appropriateness of each risk, as well as the description and categorization of each risk in the Risk Matrix; and
- Identified risks not already logged in the Risk Matrix.

Following identification of risks associated with the Project, participants evaluated:

- The likely probability of each risk event occurring; and
- The severity of the consequence to the Project should each risk event occur.

On March 18, 2013, the Project Team facilitated a second Risk Workshop to further refine the applicability, probability and severity of risks identified in the Preliminary Risk Workshop. Participants again included representatives from ODOT, KYTC, and FHWA, as well as members of the Project Team.

## 3.4 OVERVIEW OF PROJECT DELIVERY OPTIONS

### 3.4.1 PROJECT DELIVERY OPTIONS

A variety of options exist to deliver the Project scope. In general, these options compare the possibility of delivering the Project via traditional public sector procurement against a variety of alternative delivery methods. The options under consideration for inclusion in this analysis are discussed below.

The Project team resolved that a DBB delivery approach offered no significant quantitative or qualitative advantages over any of the other delivery models being considered as part of the Options Analysis. Therefore, no further quantitative analysis was performed on this project delivery method. In particular:

- A DBB does not offer any capital or O&M cost savings relative to the other delivery models;
- The Project procurement schedule for a DBB tends to be considerably longer than a DB or DBFOM alternative; and
- The structure of a DBB can expose the public sector to significant risks that may be mitigated through the selection of a DB or DBFOM delivery model

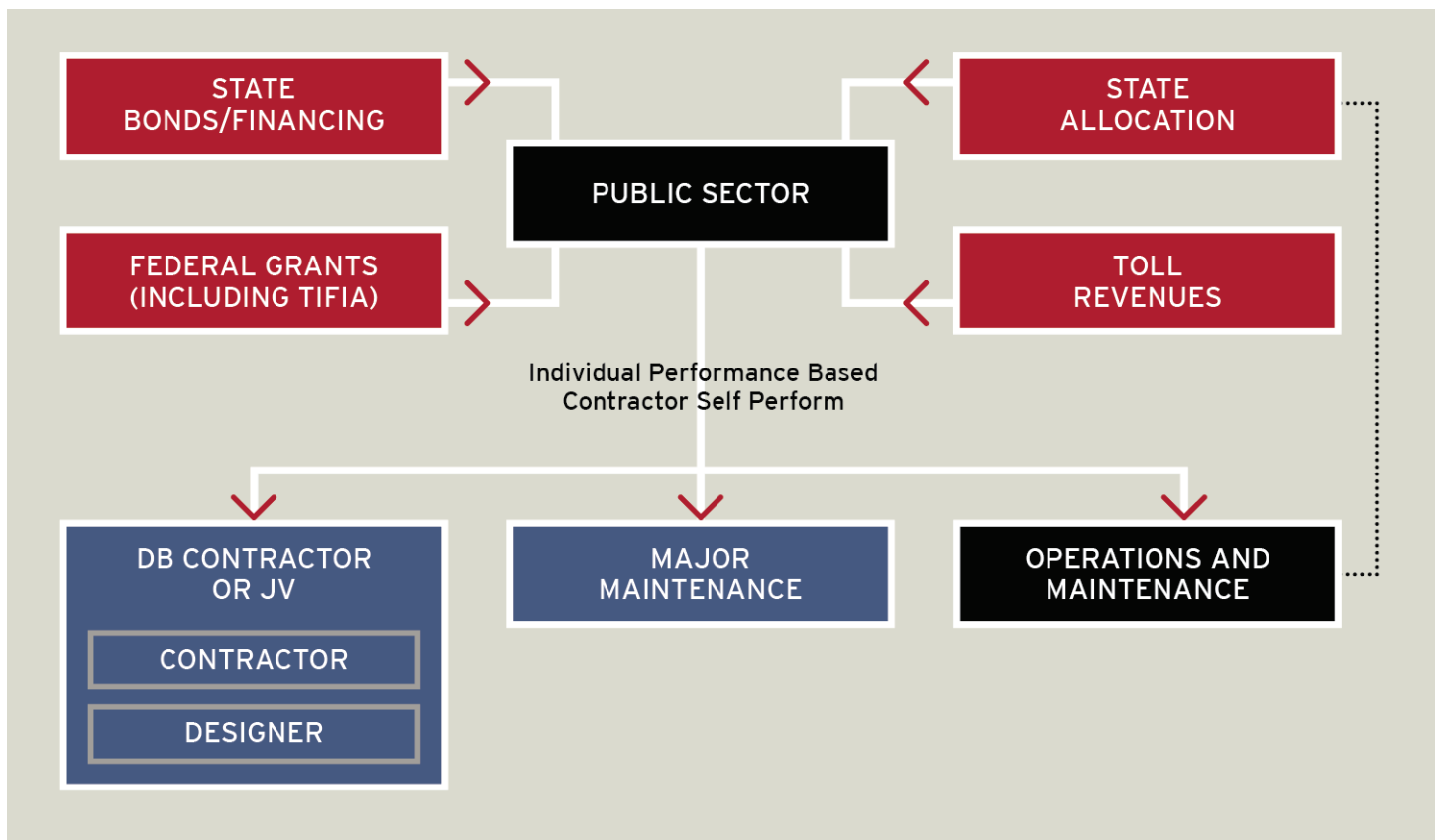
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graph TD
    SB[STATE BONDS/FINANCING] --> PS[PUBLIC SECTOR]
    FG[FEDERAL GRANTS] --> PS
    PS --> SA[STATE ALLOCATION]
    PS --> TR[TOLL REVENUES]
    PS --> IPB[Individual Performance Based]
    PS --> CSP[Contractor Self Perform]
    IPB --> D[DESIGNER]
    IPB --> OM[OPERATIONS AND MAINTENANCE]
    CSP --> C[CONTRACTOR]
    CSP --> MM[MAJOR MAINTENANCE]
    D -.-> C
    OM -.-> MM
  
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### 3.4.1.2 Design-Build (DB)

This model transfers a majority of the design and construction risk to the private sector by selecting one private entity to perform both functions, which can be a single firm or a joint venture. Instead of relying exclusively on the lowest compliant bid, design-build selections are generally based on a “best value” assessment using preliminary design documents and qualitative evaluation criteria. Integration of design and construction mitigates some of the schedule risk associated with project delivery; however risks still exist with respect to final costs, depending on the specific commercial provisions included in the contract. The public sponsor retains the obligation to fund and finance development of the Project, in addition to management of contractors performing long term operations and maintenance. For the purpose of this analysis and based on the States’ DB experience, the DB Model is considered to represent the most advantageous method of publicly funded/financed delivery. For the purpose of this analysis, it is assumed that the DB delivery alternative may be partially funded and financed using toll revenues. A typical DB structure is illustrated in **Figure 3-9**.

**Figure 3-9: DB Model Structure**



### 3.4.1.3 Design-Build-Finance-Operate-Maintain (DBFOM) – Availability Payments

In this model, illustrated in **Figure 3-10**, the private partner is responsible for the design, build, financing, operation and maintenance of the Project. Typically, a private entity takes responsibility for the project's delivery on a fixed price; date certain basis with lifecycle and maintenance risks being transferred over a long time horizon, i.e.; construction period plus 35-years. The private developer takes these long-term operations and maintenance responsibilities according to a clear performance specification in the concession agreement. Contract provisions will specify operating and performance standards to which the asset must be maintained, and "handback" requirements to ensure the asset is turned over to the public sponsor at the end of the concession within pre-determined standards.

Under this model, the public sponsor is responsible for providing a funding commitment to support the obligations of the AP concessionaire, including its project financing. Such funding is generally supported by public funds or dedicated tax revenues subject to annual or biannual appropriations. For tolled AP projects, revenues are retained by the public sponsor as potential reimbursement for its AP obligations, and demand toll revenue risk is not transferred to the private concessionaire. Public sponsor payments to the concessionaire take the form of maximum predetermined annual installments (known as "maximum Availability Payments") conditional on the transportation facility being made "available" and compliant with contracted performance specifications. The concessionaire uses these payments to pay operating and maintenance costs, cover debt service, and provide returns to equity investors.

In this model, the private partner assumes the risks of the Availability Payment model described above, in addition to demand and revenue risk, or the risk that Project revenues will be sufficient to cover Project costs. Under a revenue concession model, the private partner develops the asset and enters into a long-term lease with the public sector that allows it to collect all Project revenues over the contract term. In this scenario, the private developer takes the long-term operations and maintenance responsibilities according to a clear performance specification in the concession agreement. The ability to set user fees (tolls) is generally governed by the agreement between the public and private partners, with the agreement generally stipulating limits upon which rates may be set and adjusted (for example, setting initial rates and linking

maximum increases to inflation). These agreements can also allow for revenue sharing between the public and private sectors. Contract provisions will specify operating and performance standards to which the asset must be maintained, and “handback” requirements to ensure the asset is turned over to the public sponsor at the end of the concession within pre-determined standards. In all cases described herein, including a revenue concession, ownership of the asset always resides with the public sponsor.

### 3.4.2 GATHERING PROJECT INPUTS

After defining the Project’s Scope, inputs were gathered for the DB Model and the AP Model. For both the DB Model and AP Model:

- Cost inputs including construction costs, lifecycle costs and operations and maintenance costs were provided by HNTB, following a series of technical studies of the Project site and requirements;
- Project development cost inputs were provided by KYTC, ODOT and HNTB to represent those costs that would be incurred prior to construction;
- Traffic and revenue estimates were provided by SDG;
- Financing inputs associated with the States’ traditional form of financing were developed by KPMG with reference to industry benchmarks and in conjunction with other participants at the Financial Workshop, discussed in **3.3.3**; and
- Risk inputs and adjustments were developed by HNTB and KPMG in conjunction with participants at the Risk Workshops, discussed at **3.3.4**.

Additionally, costs associated with Project development (for example, acquisition of ROW) were identified as those costs which would be incurred prior to construction, and which would not vary by delivery model. Project development costs were excluded from the financial models but were included in the Options Analysis in order to determine the total cost associated with Project delivery. **Table 3-1** summarizes the inputs between the DB Model and the AP Model.

**Table 3-1: Summary of DB Model and Alternative Delivery Model Inputs**

INPUT	DB	DBFOM AP
Revenue	Baseline projections	Baseline projections, reflecting that revenue risk is not transferred to the private sector
Pre-Development	Baseline cost projections incurred by both States, regardless of delivery model.	Baseline cost projections incurred by both States, regardless of delivery model. Additional costs assumed for establishment of special-purpose vehicle (SPV).
Construction	Baseline cost projections for construction of facility using fixed-price DB model	Baseline cost projections for construction of facility using fixed-price DBFOM model
O&M	Baseline projections for O&M, assuming both States as operator (or contracted out to third parties)	Baseline projections for O&M, assuming a private provider
Lifecycle	Baseline projections for lifecycle assuming both States as operator (or contracted out to third parties)	Baseline projections for lifecycle assuming a private operator and impact of a private sector capital maintenance strategy
Tax	Not applicable	Federal and state taxes, as well as depreciation and the correlating impact on taxation
Financing	Tax-exempt “governmental purpose” Toll Revenue Bonds and TIFIA	Private finance terms for: Tax-exempt Private Activity Bonds, TIFIA, and Equity
Inflation	Inflation rates for revenue, construction, O&M	Inflation rates for revenue, construction, O&M

Cost inputs are discussed in detail in **4.1**, and revenue inputs and assumptions are discussed in **5.1**.

### 3.4.3 CONSIDERATION OF RISK INPUTS

A central Options Analysis concept is that risks should be allocated to the party best able to manage them. As part of the Options Analysis, it is therefore crucial to outline the potential risks that might impede the Project from achieving on-schedule and within-budget completion, or disrupt and impede operations and maintenance activities. Once these risks are defined, they should be allocated between the public sector and private sector, depending upon which entity is best able to bear each given risk. At the conclusion of this exercise, the total risk-adjustment costs allocated to both the public sector and private sector will be considered as part of the Options Analysis.

The Project Team defined risks as any events which might cause the Project’s benefits and costs to adversely differ from baseline expectations. For example, a risk might delay the Project’s start of operations,



increase the cost of construction, or reduce the number of vehicles able to use the Project. More broadly, risks typically fall into the categories outlined below in **Table 3-2**.

**Table 3-2: Key Risk Categories Considered in Analysis**

<b>RISK CATEGORIES</b>	
Commercial and Financial	Legislative, Regulatory and Policy
Environmental	Planning, Permits and Approvals
Force Majeure	Technical (D&C)
Labor	Technical (O&M)
Legal	Other

While risks are often shared between parties, the private sector partner may decide against bearing certain risks. For example, the risk of managing the cleanup of hazardous material is difficult to quantify financially, and as a result a private sector partner may prove unable to factor this into their overall pricing structure, and therefore refuse to accept this risk. In other cases, a risk might fall outside the expertise of the private sector, and be best borne by the public sector. Change in law risk, for example, is traditionally borne by the public sector, since the public sector is directly responsible for creating and changing laws and regulations.

After potential risks have been identified and responsibility is allocated for each risk, risks are then quantified. Quantification of risks requires the risk be given a probability of occurrence and overall cost, which helps monetize the risk identified. In addition, if the risk affects the timing of the project, causing delays in the estimated schedule, the costs of these events also need to be quantified.

It should be noted, however, that risk allocation may change over time, since the consequences and impacts of risks will generally be reassessed throughout the procurement process. In some cases, risks can even be managed out of projects over time, as they become better understood and methods of mitigation are developed.

The identification, quantification and allocation of risks as they apply to the Project are discussed in detail in **Section 6**.

### **3.4.4 REQUEST FOR INFORMATION**

ODOT issued a Request for Information (RFI) for the Project on December 20, 2012. The purpose of the RFI was to generate industry interest in the Project, and to elicit responses from individual firms or teams that have experience in developing and/or financing large transportation infrastructure projects. The RFI indicated that ODOT, KYTC and FHWA were exploring tolling options, public funding options, and private financing options that could be part of either an Availability Payment or toll revenue concession. The RFI

posed four questions for respondents to address regarding Project scope and phasing, and 13 questions regarding Project financing and delivery methodology.

The RFI was not part of a formal procurement process and was not a prerequisite for teams to participate in a future procurement process. Potential respondents were told that a response would not provide any preference, special designation, advantage or disadvantage in any subsequent procurement process. Respondents were told they would not be reimbursed for any information provided or administrative cost incurred in responding to the RFI. Respondents were told that any information provided could be publicly disclosed at ODOT's and KYTC's sole discretion and would not be considered protected or proprietary.

Twenty-three responses were submitted representing a total of 31 companies, as some individual responses were submitted by multiple firms. **Table 3-3** provides a summary of respondents and companies represented.

**Table 3-3: Summary of RFI Respondents**

RESPONDENT	FIRMS REPRESENTED	
Abertis USA	• Abertis USA	• Abertis Infraestructuras SA
ACS	• ACS Infrastructure Development, Inc	• Dragados USA, Inc.
AECOM	• AECOM	
Balfour Beatty Investments	• Balfour Beatty Investments	• Parsons Brinckerhoff
Bechtel	• Bechtel Infrastructure Corporation	
Bilfinger Project Investments North America Inc.		
Cintra	• Cintra Infraestructuras, S.A.	• Ferrovial Agroman US Corp.
FCC Construcción S.A.	• Fomento de Construcciones y Contratas	
InfraRed Capital Partners		
John Laing	• John Laing (USA) Limited	
Kiewit, Walsh and Kokosing	• Kiewit Infrastructure Group • Kokosing Construction Company	• Walsh Construction
Macquarie Capital	• Macquarie Capital (USA) Inc.	
Meridiam, Fluor, Lane, Traylor Bros, DBi, HDR and Buckland & Taylor	• Meridiam Infrastructure North America, Corp. • Fluor Enterprises, Inc. • The Lane Construction Corporation • Traylor Bros., Inc.	• DBi Services • HDR, Inc. • Buckland & Taylor Ltd.
Parsons		

RESPONDENT	FIRMS REPRESENTED	
Plenary Group	• Plenary Group (USA) Ltd.	
PNC	• PNC Capital Markets LLC	• PNC Bank
<b>Port of Greater Cincinnati Development Authority</b>		
<b>Samsung Construction &amp; Trading Corporation</b>	• Samsung Engineering & Construction America, Inc.	
<b>Shikun &amp; Binui</b>	Shikun & Binui	
<b>Skanska</b>	• Skanska AB • Skanska Infrastructure Development	• Skanska USA Civil • Skanska USA Building
<b>SNC Lavalin</b>	SNC Lavalin Capital	
<b>VINCI</b>	• VINCI Concessions, S.A.S.	• VINCI Construction Grand Projects (VCGP)
<b>Zachry Construction Corporation</b>	Zachry Construction Corporation	

The following key themes emerged following a review of the RFI responses (in no particular order of importance):

- **Project size and scope:** While it was generally acknowledged that the Project is large and complex from a construction perspective, the size alone would not deter the market participation. However decisions on delivery mechanism, risk allocation and payment mechanism would have a more direct bearing on the decision to pursue a formal procurement. Phasing of the project was generally discouraged.
- **Opportunities for innovation:** The size and scope of the Project may present a wide range of opportunities to deliver innovative solutions that drive down project costs and reduce project schedule through, for example, material selection, design of approaches, structural considerations and the application of performance-based specifications.
- **Procurement process:** Clarity, transparency and leadership in the procurement process were identified as important issues that need to be discussed and resolved to permit an effective and efficient process. Equally, respondents voiced a desire for a “reasonable” procurement schedule that balances the desire of the States to move the Project forward with the needs of the market to assess the Project and develop competitive bids.
- **Appetite for alternative delivery mechanisms:** All respondents except one expressed a desire to pursue either an Availability Payment concession or a toll revenue concession model citing the benefits of the transfer of key project risks from the public sector to the private sector and the ability of the private sector to manage those risks as key drivers.

- **Challenges to overcome:** The bi-State nature of the Project raised several concerns from the market and the absence of sufficient clarity of purpose with respect to the desire of both States to pursue the Project may have an adverse effect on the market's participation of a future procurement. Both States have a strong desire to deliver the Project, but may differ in the extent to which they can use alternative delivery models. Key items cited by respondents included: clarity regarding the bi-State political and financial support for the Project; the desire for a single procuring body; the need for explicit enabling legislative action in Kentucky; and legislation regarding video capture and toll enforcement.
- **Risk transfer:** Respondents expressed a strong desire that to the extent an alternative delivery model is selected, the operations, maintenance and lifecycle responsibilities associated with the Project be transferred to the private sector. This applied to both the roadway and bridge portions of the project leading to the "optimization of long-term [operations and maintenance]" and an ability to unlock the "greatest advantages to public sector" in terms of value delivered over the life of the asset.

### 3.5 DELIVERY MODELS TO BE ANALYZED

This Options Analysis considered two P3 delivery approaches as potential Alternative Delivery Models: a DBFOM Availability Payment Model (that is, an AP Model) and DBFOM Toll Revenue Concession Model (see **3.4.1** for details). Although both were deemed potentially suitable for Project delivery, ODOT and KYTC determined that the risk profile and limited private sector appetite for a DBFOM Toll Revenue Concession Model made it unattractive relative to the DBFOM Availability Payment Model. For this reason, the proceeding quantitative analysis considers only the AP Model and the DB Model.

## 4. COST ASSUMPTIONS

### 4.1 COST INPUTS

For the alternative river bridge concepts, cost estimates were based on not only the available cost information for Alternative I, but also based on recent relevant experience delivering design and construction services for several network tied arch bridges in recent years. The contract bid item prices from these bridges along with published unit bid price tables from ODOT and KYTC were used to develop the initial cost estimate for a new network tied arch river bridge with plumb ribs, 12' outside and 8' inside shoulders, and 870' main span. The unit costs were adjusted to account for site conditions, construction staging, proximity to fabrication plants, and also the complexity of the double-decker configuration including maintenance of traffic during construction.

After adjustments were made, the estimates were further refined. A preliminary analytical model of an 870 feet main span network tied arch was developed to better estimate steel and concrete quantities. In addition, the total price in terms of major high-cost components which include the deck, arch rib and floor system, cables, bearings and joints, and, substructure concrete volumes were estimated based on modeling and past quantity history from similar network tied arch bridges. Like the cost estimate for preferred Alternative I, a design contingency of 17% was included in the estimate. A review of the preferred Alternative I cost estimate shows that the costs given in the Project's February 2012 FHWA Cost Estimate Review spreadsheet are reasonable for the inclined tied arch and two-tower cable stay bridge options. **Table 4-1** summarizes the estimated initial construction costs<sup>14</sup> in current year (2012) dollars for preferred Alternative I and Alternative I-A which includes the alternative bridge concepts noted above.

**Table 4-1: Estimated Initial Base Construction Costs for Alternatives I and I-A (Real 2012 \$)<sup>15</sup>**

	ALTERNATIVE I (REAL \$M)	ALTERNATIVE I-A (REAL \$M)	COST DIFFERENCE (REAL \$M)
Kentucky approach	422.0	422.0	–
Ohio approach	599.8	599.8	–
River Bridges <sup>16</sup>	514.1	324.2	150.1
<b>Total</b>	<b>1,496.1</b>	<b>1,346.0</b>	<b>150.1</b>

<sup>14</sup>The initial construction costs include incidentals costs and design contingency percentage used for the applicable segment in the FHWA Cost Estimate Review spreadsheet dated February 2012.

<sup>15</sup>The River Bridges costs for Alternative I include the cable-stayed option (Alternative 3 - two-tower, three vertical legs/tower) from the March 2011 Bridge Type Selection Study.

<sup>16</sup>Alternative I assumes a span length of 1000' and a bridge type of Inclined Tied Arch. Alternative I-A assumes a span length of 870' and a bridge type of Network Tied Arch. Bridge replacement costs are not included in the River Bridges base construction costs.

The Life Cycle Cost Analysis (LCCA) was completed in accordance with the FHWA's technical guidance to create a Present Value (PV) comparison for Alternatives I and Alternative I-A. The FHWA guidance includes two major components, namely:

- Agency costs (the construction cost, repair and rehabilitation costs, and routine operations and maintenance costs); and
- User costs.

User cost differences were not calculated for this LCCA.

The PV is the value of all future cash flows discounted back to current year dollars per FHWA guidance. The median PV of the total lifecycle costs analyzed for preferred Alternative I and Alternative I-A were established before and after deducting residual values. These PV calculations utilized a real discount rate based on a composite of high-quality, long-term municipal bond rates for Ohio and Kentucky reduced by the Federal Government's estimate of long-term inflation. The median Net Present Value comparison shows that by choosing to implement Alternative I-A as compared to preferred Alternative I, approximately \$138 million of savings in current year dollars could be realized before residual values are deducted and \$83 million savings net of the residual values. However, for purposes of this analysis, Alternative I cost estimates have been adopted.

#### 4.1.1 BASE CONSTRUCTION COSTS

##### 4.1.1.1 Cost Assumptions

The unit costs were adjusted to account for site conditions, construction staging, proximity to fabrication plants, and the complexity of the double-decker configuration including maintenance of traffic during construction. After adjustments were made, the estimates were further simplified to capture the total price in terms of major high-cost components which include the deck, arch rib and floor system, cables, bearings and joints, and, substructure concrete volumes. Like the cost estimate for preferred Alternative I, a design contingency of 17% was included in all estimates. A review of the preferred Alternative I cost estimate shows that the costs given in **Table 4-1** are reasonable for the arch and two-tower cable stay bridge options.

##### 4.1.1.2 Cost Estimates

**Table 4-2** summarizes the estimated initial construction costs<sup>17</sup> for preferred Alternative I across both delivery models under consideration.

<sup>17</sup>The initial construction costs include incidentals costs and design contingency percentage used for the applicable segment in the FHWA Cost Estimate Review spreadsheet dated February 2012.

Table 4-2: Estimated Initial Base Construction Costs for Alternative I (Year of Expenditure \$)<sup>18</sup>

INPUT OR ASSUMPTION	DB MODEL AND AP MODEL	
	YOE (\$M)	PV (\$M) <sup>19</sup>
Kentucky Approach	480	423
Ohio Approach	684	600
River Bridges	586	515
Utilities Costs	89	88
PE/CEI	184	170
Design Contingency (17%)	279	276
<b>Total</b>	<b>\$2,302</b>	<b>\$2,073</b>

The 17% design contingency reflects uncertainty that actual design and construction costs will exceed current cost estimates, as current cost estimates are based on preliminary design. This conservatively accounts for the inherent risk associated with Project delivery under the DB Model and the AP Delivery Model.

## 4.1.2 RIGHT OF WAY COSTS

### 4.1.2.1 Cost Assumptions

In addition to the Base Construction Costs detailed above, the Options Analysis includes the Right of Way (ROW) costs, which are costs associated with the development of the Project prior to construction. These costs are most likely to be borne by the States prior to construction under both the DB Model and the Alternative Delivery Models. Accordingly, these costs will not vary between each of the financial models in the Options Analysis.

### 4.1.2.2 Cost Estimates

Under both delivery models, the States are expected to incur ROW costs of \$61 million in YOE and PV terms.

<sup>18</sup>Note: Risk adjustments associated with these costs can be found in Table 6-1.

<sup>19</sup>For this analysis, a discount rate of 5% is used as a proxy for the States' long term cost of capital.

## 4.2 ROADWAY AND TOLLING OPERATIONS AND LIFECYCLE COSTS

### 4.2.1 COST ASSUMPTIONS

The Options Analysis also includes cost forecasts for routine roadway O&M as well as tolling O&M related to the customer service center and video processing. Routine O&M costs were established based on historical expenses within the project corridor applied to the proposed project configuration. The tolling O&M component was derived using standard industry assumptions for similar facilities.

Over a projected 50 year period, different Project components will deteriorate at different rates. For example, the approximate lifecycle for concrete pavement is approximately 35 years. Between initial construction of the pavement in Year 1, through its replacement in Year 35, numerous repairs and maintenance will be performed such as pavement joint repair, patching, and overlays.

Routine maintenance operations such as snow removal and mowing also need to be estimated and incorporated into overall project costs. Operations and maintenance costs were provided by both KYTC and ODOT based on historic O&M costs for the interstate routes in the project area and the existing BSB. These costs were distributed into costs per highway lane mile, and then summarized for both approaches and the river bridge.

Toll collection assumes the customer will either use a registered transponder to pay the toll or a photo of the vehicle's license plate will be captured for processing. The photo will be used to identify the registered owner of the vehicle and send them a video bill in the mail to pay the toll. Non-payment of the video bill will result in pursuing the customer through violation enforcement process.

Capital costs for the toll system included the cost for equipment and necessary infrastructure located on the side, in the pavement or over the roadway to detect vehicles and electronically gather information for payment collection purposes. Other capital costs included the cost of all associated systems, software and offsite components to process the tolls collected. Maintenance costs assumed included the annual routine maintenance of the toll system and recurring life cycle replacement costs. Operations costs included the costs to collect the tolls through offsite account management operations. An offsite account management back office operation was assumed for the processing of tolls through customer accounts for transponders and video billing. The tolling locations will connect to the back-office system that houses the Customer Services Center and Video Processing System.

The states have not yet established a toll policy. Therefore, this analysis includes certain assumptions, summarized in **Table 4-3**, which are based on industry precedent. Such assumptions will be refined based on inputs from states as legislation and policies are formulated.



Table 4-3: Summary of Assumptions for Roadway and Toll Operations and Maintenance Costs

COST CATEGORY	COST ASSUMPTIONS
<b>Roadway O&amp;M Costs</b>	<p>O&amp;M costs were established to include routine maintenance activities of O&amp;M, equipment and snow that are generally performed by local maintenance personnel or account-type contracts. A conservative O&amp;M assumption of \$6,500 per lane mile was used in the Options Analysis. These types of activities include, but are not limited to the following:</p> <ul style="list-style-type: none"> <li>• Inspections (bridge, sign structures, signs, traffic signals, etc.)</li> <li>• Routine Bridge Repairs (spall removals, railing repairs, etc.)</li> <li>• Cleaning Bridges, Curbs, Gutters, Medians, etc.</li> <li>• Cleaning and Repairing Drainage Structures and Ditches</li> <li>• Lighting Maintenance (poles, lights, conduits, wiring, etc.)</li> <li>• Litter Patrol and Pickup</li> <li>• Graffiti Removal</li> <li>• Care of Shrubs, Plants, Trees</li> <li>• Mowing, Seeding, Sodding, and Fertilizing</li> <li>• Routine Roadway Repairs (Pothole Patching, Guard Rail Replacement, etc.)</li> <li>• Pre-treating for Snow and Ice and Plowing</li> <li>• Traffic Detours</li> <li>• Incident Response</li> </ul>
<b>Toll Capital Costs</b>	<p>Total toll system capital costs are estimated at \$11 million and include toll system acquisition and implementation costs, and contractor procurement and oversight items. Upfront capital cost estimates include:</p> <ul style="list-style-type: none"> <li>• IAG Multiprotocol Reader; AVI antenna on stripe (including stripe between travel lanes and shoulders) and center of each travel lane; one reader included for each antenna</li> <li>• Roadside cabinets with climate control (houses 3-4 AVI readers per cabinet)</li> <li>• Front and rear cameras for all lanes (including shoulder)</li> <li>• AVI coverage for all travel lanes. Antennas on center of lane and stripe</li> <li>• Full suite of AVC on travel lanes with redundant sensors. Shoulders will only have vehicle detection and trigger but not class sensors</li> <li>• An independent Video Audit System</li> <li>• Installation of in pavement loops and sealing of detection, classification and cameras triggering loops</li> <li>• Installation and connection of the toll equipment on the gantry and in the roadside cabinets/shelter</li> </ul>
<b>Toll Lifecycle</b>	Lifecycle costs are based on the following:

COST CATEGORY	COST ASSUMPTIONS
<b>Costs</b>	<ul style="list-style-type: none"> <li>• Lane hardware repair and replacement is supported by the spare parts inventory which is maintained at \$250,000 per year</li> <li>• Back office systems are completely replaced every five years at \$1,000,000</li> <li>• Every 10 years the entire system is replaced</li> </ul>
<b>Toll Operations Costs</b>	<p>O&amp;M tolling costs are based on the following:</p> <ul style="list-style-type: none"> <li>• Bills sent out to video patrons on a monthly basis. Three levels of billing will be implemented with a \$2.50 late fee on Level 2 and an additional \$2.00 fine per outstanding transaction</li> <li>• 75% of traffic is considered “in-state,” defined as either Kentucky or Ohio for the purposes of differentiating costs of registered owner identification</li> <li>• Transponder percentages and growth               <ul style="list-style-type: none"> <li>○ 2018 - 50% cars, 65% trucks</li> <li>○ 2028 - 70% cars, 85% trucks</li> <li>○ Market penetration for each vehicle type grows by 2% each year from 2018-2028 with no additional growth in ETC market share from after 2068</li> </ul> </li> <li>• Credit card payment percentages are 70% for ETC customers and 40% of video customers               <ul style="list-style-type: none"> <li>○ Credit card fees assumed at a rate of 2.25% of the toll revenue</li> </ul> </li> <li>• Transponder toll collection costs assume 9 cents per transaction</li> <li>• Video billing process steps and assumptions:               <ul style="list-style-type: none"> <li>○ Image loss at lane are conservatively assumed at 5%</li> <li>○ Automatic License Plate Recognition (ALPR) conservatively only reads 60% of images</li> <li>○ Manual review of all remaining images at 7.5¢ per image</li> <li>○ Instate lookup costs (Kentucky or Ohio) are free while out-of-state are assumed at 50¢ per uniquely-identified license plate</li> <li>○ Each video bill (at each level of invoicing) costs \$1.25 to prepare and send</li> <li>○ Approximately 10% of Level 1 invoices are undeliverable due to outdated or inaccurate registered owner data</li> <li>○ Video bills are paid with the following response rates per level:                   <ul style="list-style-type: none"> <li>○ Level 1 - 50%, Level 2 - 30%, Level 3 - 20%; Overall response rate - 72%</li> </ul> </li> <li>○ Each paid video bill costs \$1.50 to process</li> </ul> </li> </ul>

#### 4.2.2 COST ESTIMATES

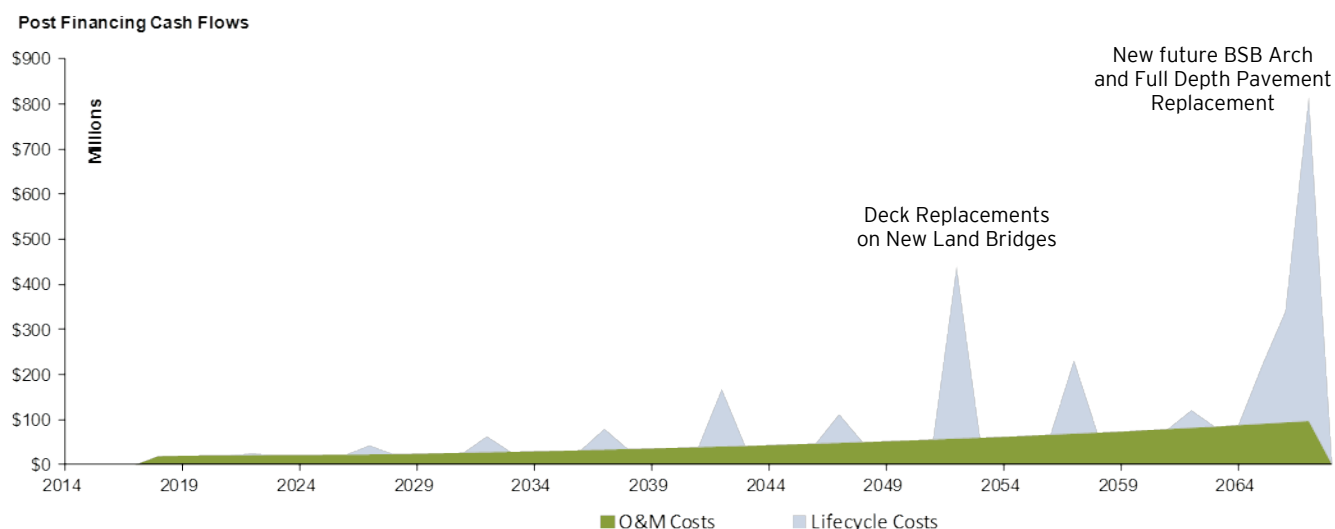
**Table 4-4** summarizes the Toll System capital (i.e.; lifecycle), operations and maintenances costs under Alternative I.

Table 4-4: Estimated Initial Base Toll System Lifecycle, Operations and Maintenance Costs

INPUT OR ASSUMPTION	DB AND AP MODELS		
	FIRST YEAR COSTS YOY(\$M)	TOTAL COSTS YOY (\$M)	TOTAL COSTS PV (\$M) <sup>20</sup>
<b>ROADWAY AND BRIDGE O&amp;M COSTS</b>			
O&M Cost #1 - KY approach	0.2	20.0	4.6
O&M Cost #2 - OH approach	0.3	28.2	6.4
O&M Cost #3 - River Bridges	0.1	6.3	1.4
O&M Cost #4 - Customer Service Center	0.6	917.8	176.8
O&M Cost #5 - Video Processing Center	11.7	1,298.2	271.9
O&M Cost #6 - Routine Maintenance	3	37.8	8.6
<b>Total Operations &amp; Maintenance</b>	<b>16.1</b>	<b>2,308.3</b>	<b>469.8</b>
Lifecycle Cost #1 - KY	–	485.2	63.1
Lifecycle Cost #2 - OH	–	602.9	85.3
Lifecycle Cost #3 - River Bridges	–	718.3	60.4
Lifecycle Cost #4 - Equipment Replacement	–	168.2	31.6
<b>Total Lifecycle Costs</b>	<b>–</b>	<b>1,974.7</b>	<b>240.4</b>
<b>Total</b>	<b>16.1</b>	<b>4,282.9</b>	<b>710.3</b>

The peaks that appear in **Figure 4-1** are a combination of lifecycle costs and the major maintenance items that are necessary to preserve the long-term condition of the Bridge. Two of the most significant expenditure items are indicated.

<sup>20</sup> For this analysis, a discount rate of 5% is used as a proxy for the States' long term cost of capital.

**Figure 4-1: Estimated Lifecycle, Operations and Maintenance Costs (Year of Expenditure \$)**

### 4.2.3 FINANCING ASSUMPTIONS

Financing assumptions were discussed during the Financial Workshop, and subsequently at the meeting on May 29, 2013 with KYTC and ODOT, and have been developed with reference to:

- Financial Workshop participant feedback;
- Prevailing market rates; and
- Recent comparable market activity.

For the DB Model, conservative and optimistic financing scenarios have been adopted to reflect the range of coverage ratios that the DB Model might achieve. Market precedent supports the coverage ratios for the AP Model, and for this reason only a conservative scenario has been adopted. **Table 4-5** summarizes the range of financing assumptions for the Project.

Table 4-5: Financing Inputs and Assumptions

INPUT OR ASSUMPTION	DB MODEL		AP MODEL
	CONSERVATIVE	OPTIMISTIC	CONSERVATIVE
<b>Structure and Assumptions</b>			
Capital Structure (Debt : Equity)	Not Applicable	Not Applicable	90-95: 10-5
Target Equity Return	Not Applicable	Not Applicable	12.5%
<b>Senior Debt</b>			
Type of Senior Debt	Toll Revenue Bonds (CIB/CAB)	Toll Revenue Bonds (CIB/CAB)	Private Activity Bonds (PABs)
Term	CIBS: 40 years CABS: 30 years	CIBS: 40 years CABS: 30 years	38 years + 2 year tail
Minimum DSCR <sup>21</sup>	2.75x	2.25x	1.25x
<b>Subordinate Debt</b>			
Type of Subordinate Debt	Toll Revenue Bonds (CIB)	Toll Revenue Bonds (CIB)	Not Applicable
Term	CIBS: 40 years	CIBS: 40 years	Not Applicable
Minimum DSCR	1.48x	1.48x	Not Applicable

#### 4.2.3.1 TIFIA Assumptions

The *Transportation Infrastructure Finance and Innovation Act* (TIFIA) program provides federal credit assistance in the form of direct loans, loan guarantees and standby lines of credit, which may be used to finance nationally significant surface transportation projects. TIFIA credit assistance could potentially advance the Project by offering more flexible repayment terms and attractive interest rates than are ordinarily available in private capital markets.

<sup>21</sup>The DSCR for the DB Model was calculated as Project Revenues less Nominal O&M Costs divided by Debt Service. The DSCR for the AP Model was calculated as Project Revenues less Nominal O&M and Nominal Lifecycle Costs divided by Debt Service. The difference between the DB Model and the AP Model is due to the different considerations of lifecycle risks (and how those risks are transferred) by the respective lenders to the DB Model and to the AP Model. The Minimum DSCR was calculated as the lowest DSCR over the lifespan of the Project

TIFIA financing may improve the overall financial viability of the Project; however its availability is subject to an application process under the MAP-21 framework. Due to this application process, while the Options Analysis considers as its base case a scenario with TIFIA under each delivery model, we have also provided a summary of the key outputs without TIFIA being included in the capital structure in order to estimate the outcome if the states are not successful in receiving a TIFIA allocation. For the scenarios that include TIFIA as part of the financing solution, the assumptions shown in **Table 4-6** have been adopted.

**Table 4-6: TIFIA Financing Inputs and Assumptions**

INPUT OR ASSUMPTION	DB MODEL	AP MODEL
Maximum Size	Lesser of 33% of eligible costs or 50% of total debt	Lesser of 33% of eligible costs or 50% of total debt
Term	5 years construction + 35 years operations = 40 years total	5 years construction + 31 years operations = 36 years total
Minimum DSCR	1.48x	1.25x

#### 4.2.3.2 Discount rate assumptions for risk adjusted cash flows

After adjusting the cash flows to reflect risk and other costs, the cash flows for each model are evaluated on a Net Present Value basis. The Net Present Value of the cash flows presents the States with a view of what each model's projected cash flows are worth in present terms, thereby approximating the "whole life" cost of the delivery model.

The crucial component in estimating the Net Present Value of a particular delivery model is the rate at which the risk adjusted cash flows are discounted (discount rate). Discounting a particular period's cash flows captures the time value of money and allows for cash flows from different periods to be assessed in present value terms.

For this analysis, a discount rate of 5% is used. This number is a proxy for the States' long term cost of capital in the current tax-exempt markets.

#### 4.2.3.3 Discount rate assumptions for non-risk adjusted excess cash flows

Excess cash flows are defined as all excess toll revenues remaining during each operating period at the bottom of the cash flow waterfall<sup>22</sup>. To assess the value of the excess cash flows expected over the life of the Project, these cash flows should be discounted at a rate that reflects the time value of money and the risks

<sup>22</sup>The cash flow waterfall has the following priority for cash outflows: administrative expenses, operations and routine maintenance expenses including tolling systems O&M, interest payments, principal repayments and periodic major maintenance expenses (including major maintenance reserve funding).

associated with the ultimate realization and collection of these cash flows. At a high level, such risks include but are not limited to:

- Project development/delivery risks
- Traffic and revenue risk;
- Operating, maintenance and lifecycle costs;
- Compliance with potential handback requirements at the end of the Project;
- Inflation risk; and
- Regional and national economic risk.

The discount rate used to calculate the present value of excess cash flows should appropriately consider all of the risks associated with the operation of the facility on a standalone basis over the term of the Project. A discount rate of 8.5% has been adopted for the Project (for both the DB Model and the AP Model), which has been developed with reference to the two approaches outlined below.

- **Capital Asset Pricing Model (CAPM) Approach:** This approach is used to estimate the cost of capital associated with a particular project. It uses a range of input variables and market indicators to help assess the discount rate that should be applied to the Project.
- **Market Comparables Approach:** This approach uses the equity internal rate of return observed in comparable market transactions to derive an appropriate rate of return for the Project. Based on a review of toll road projects throughout North America and internationally, a discount rate of 8.5% is considered reasonable and properly reflects the level of risk associated with the stream of excess cash flows.

## 5. TRAFFIC & REVENUE STUDY

### 5.1 REVENUE INPUTS

A crucial input into the Options Analysis is expected revenues from users of the Brent Spence Bridge. The Project Team developed forecasts for traffic and revenue (T&R) on the Brent Spence Bridge from 2018 to 2068.

Several essential issues need to be addressed in the T&R modeling:

- What will be the corridor volume crossing the Ohio River in the Cincinnati-Covington region?
- How will users respond to a toll in a corridor where none currently exist? How will users trade off the value of time (VoT) savings and reliability with toll charges?
- How will the tolling technology used affect both usage and gross revenue?
- What impacts will the imposition of a toll have on alternative crossings?

The Project Team relied on several models and data sources. The principal tool was the existing Ohio-Kentucky-Indiana Regional Council of Governments/Miami Valley Regional Planning Commission Travel Demand Model (OKI-TDM), a conventional four-step travel demand model that provides a wealth of information regarding the road network and origin-destination patterns of users. The OKI-TDM is an equilibrium model that can separate two principal effects engendered by an expanded Brent Spence Bridge: On the one hand users will be attracted to the future Brent Spence for its additional capacity, but on the other they will also see some diversion to other crossings because of the imposition of a toll.

For each scenario and toll rate tested, HNTB used the OKI-TDM (see **Figure 5-1**) and extracted sub-area trip and a corresponding sub-area network to SDG for their Sub-Area model analysis. Additionally, HNTB incorporated the effect of tolls on the trip distribution and trip assignment phase of the OKI model.

The OKI-TDM covers a large area and includes multiple counties. In order to facilitate the analysis of traffic and revenues for the Brent Spence Bridge and the five alternative crossings, the sub-area origin-destination matrices and sub-area networks were aggregated by SDG into a Sub-Area Model. The Sub-Area Model keeps disaggregated and detailed the network and origin-destinations that use the six river crossings that comprise the Brent Spence “corridor” (the Brent Spence, Clay Wade Bailey, Roebling, Taylor Southgate (Central), Daniel Carter Beard and I-275 bridges), while aggregating the rest of the OKI-TDM that is peripheral to it.

The OKI-TDM was also supplemented with an econometric model of the corridor, generally defined as including the Brent Spence and the five alternative river crossings. The corridor Econometric Model was used to develop more precise estimates of corridor traffic growth, both in the opening year 2018 and well as future subsequent years.

The Econometric Model ties traffic on the Brent Spence Corridor directly to economic factors: GDP and fuel prices. The model estimates use traffic counts (in AADT) for all six crossings, which are combined into a single dataset. The model estimation yields very significant results, with an R2 of over 0.99 and highly significant alternative measures of goodness-of-fit (t-statistics, F-statistics, etc.). The Econometric Model is used to generate corridor growth rates based on forecasts for GDP and fuel prices provided by Economy.com and the Energy Information Agency (EIA), respectively.



The long-term assumptions for GDP provided by Economy.com is for growth of 2.2% a year in real terms, somewhat lower than the average of 2.4% seen over the historical 1995 to 2012 period for which the model is estimated. Fuel prices are forecast by EIA to increase somewhat over the next five years then be essentially stable in real terms. These assumptions produce corridor growth in AADT of approximately 1.5% over the short and medium term.

Another component of the forecasting process is the development of a Toll Diversion Model. This model focuses entirely on the choice of users between a tolled facility and un-tolled alternatives, and incorporates estimates of Value of Time (VoT; discussed in **5.2.2**) developed by the Project Team in order to do so. The relationship between the components models are illustrated in **Figure 5-2**. Despite the extensive array of data and modeling brought to bear, the T&R forecasts developed here cannot be considered investment grade forecasts as the timeline did not permit the attendant surveys that would be characteristic of an investment-grade analysis.

Figure 5-1: Project Model Area

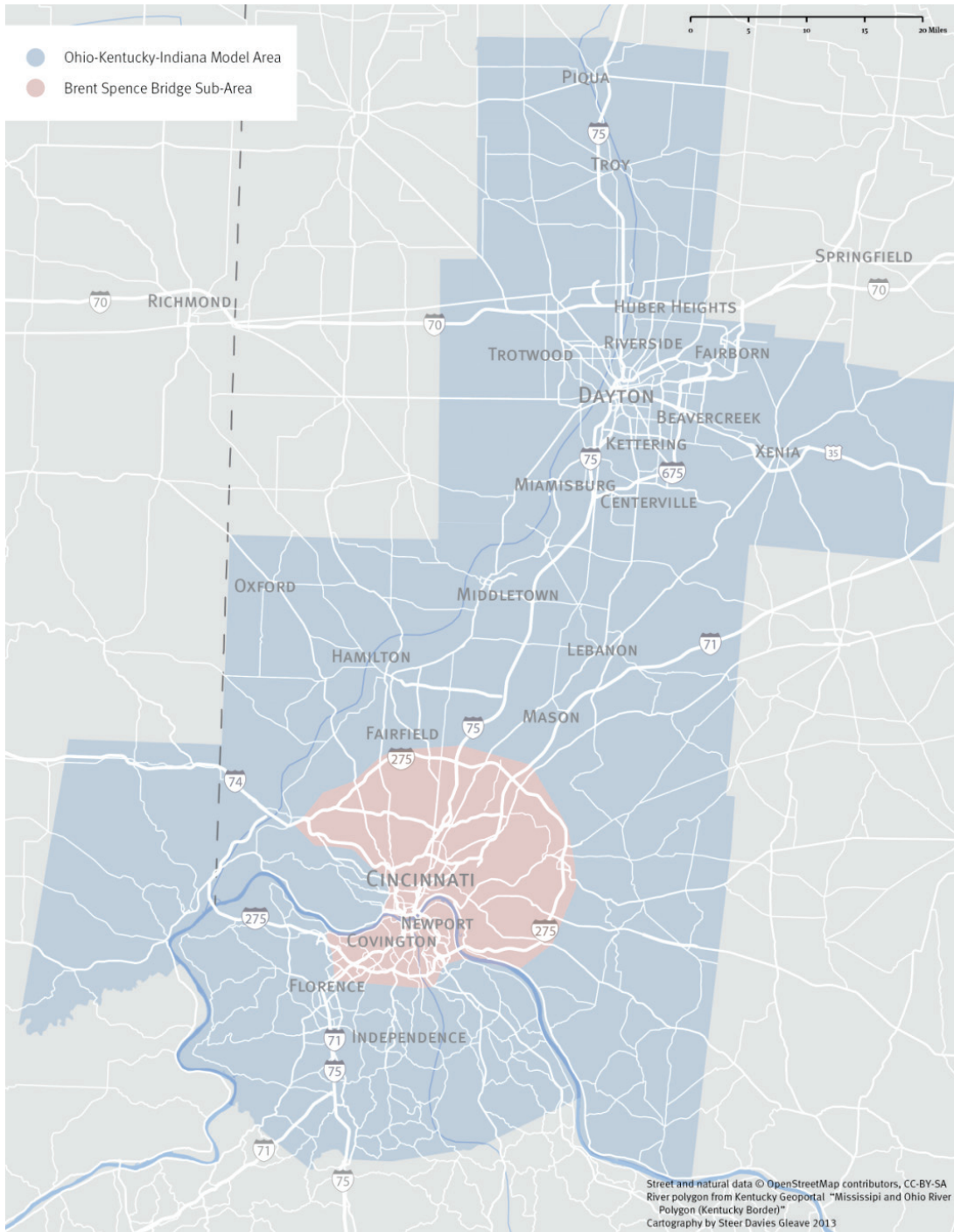
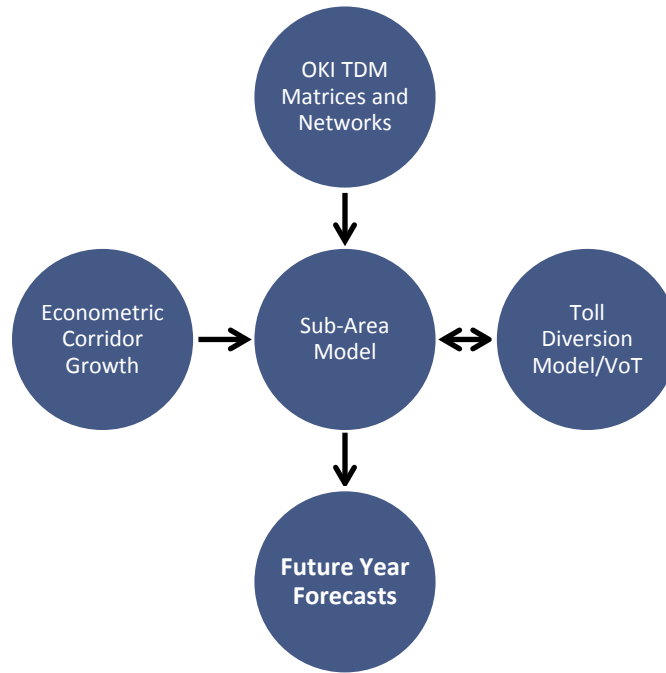


Figure 5-2: Interaction of Models for the T&amp;R Study



## 5.2 HISTORIC TRAFFIC ON THE BRENT SPENCE BRIDGE

### 5.2.1 TRAFFIC COUNTS

Traffic counts available for the Brent Spence Bridge include average daily traffic (ADT), and classification. While the former sums all vehicles, the latter distinguishes between automobiles, motorcycles, and various types of trucks.

**Table 5-1** details ADT counts for the Brent Spence Bridge. These are supplemented with ADT estimates from the corridor Econometric Model, which generates “estimates” of historic traffic based on past statistical relationships between traffic and a series of economic variables. Essentially these are model estimates that detail the expected traffic given the prevailing state of the economy during the time period in question.

Table 5-1: Average Daily Traffic on Brent Spence Bridge

YEAR	OKI AND KYTC COUNTS	ECONOMETRIC MODEL ESTIMATES
1995	N/A	121,650
1996	N/A	125,008
1997	127,000	129,911
1998	132,052	136,547
1999	143,000	141,075
2000	146,000	142,875
2001	147,000	144,960
2002	137,000	147,790
2003	149,000	149,132
2004	140,824	151,017
2005	148,928	152,136
2006	188,000	154,007
2007	156,000	155,361
2008	159,000	153,573
2009	167,000	154,177
2010	172,000*	154,944
2011	175,000*	154,313

Source: Kentucky Department of Transportation; Ohio Kentucky Indiana Regional Council of Governments; Steer Davies & Gleave (2013).

\* Indicates computer-generated counts, which were not used.

The counts and estimates in **Table 5-1** suggest that Brent Spence ADT has been in the range of 150,000 to 160,000 in the last decade. Traffic classification detail is not available for the Brent Spence Bridge itself, only for several access ramps and locations leading to the Bridge. In 2009, count Station 801 on I-75 South of the bridge recorded 15.3% of the traffic was comprised of trucks and buses. The OKI-TDM itself, suggests that truck traffic on the Brent Spence is close to 16%.

These estimates are corroborated by a recent traffic count exercise undertaken by the OKI Regional Council of Governments between April and May 2013. Counters placed on the Brent Spence Bridge recorded average

Annual Daily Traffic (AADT) of 161,036, remarkably close to the estimate derived from the econometric model. The same count exercise recorded a 20% truck share.

Existing count data does suggest that current Brent Spence daily traffic is close to 160,000, with a truck percentage of approximately 16%.

### 5.2.2 VALUE OF TIME

Value of Time is an essential input in modeling the impacts of a toll on the Brent Spence. The crucial decision facing users is deciding between a tolled facility offering greater capacity and a faster trip, and un-tolled but slower, and potentially less safe, alternatives. The Value of Time allows the conversion of tolls into time equivalents, and thereby a comparison between routes based on a single consistent metric.

The Project Team estimated Value of Time for passenger vehicles based on existing wages in the region. It is a well-established practice in transportation modeling to base Value of Time estimates on wage rates. Numerous studies based on actual behavioral trends showing that Value of Time follows fairly predictable relationships to earnings.

Commercial vehicle Value of Time was estimated based on a review of the literature, in particular a frequently cited 2003 study by Brian Smalkoski and David Levinson<sup>23</sup>.

Following these authors, a heavy truck value of time of \$61 per hour was used for heavy trucks, and \$37 for light trucks. Value of Time estimated for Single Occupancy Vehicles (SOVs), High Occupancy Vehicle (HOVs), Light Trucks and Heavy Trucks are reported in **Table 5-2**.

**Table 5-2: Value of Time for Private Vehicles**

PRIVATE VEHICLE VALUE OF TIME	VOT (\$/HR) IN 2013 DOLLARS
Single Occupancy Vehicle (SOV)	\$15
High Occupancy Vehicle (HOV)	\$17
Light Truck	\$37
Heavy Truck	\$61

*Note: Passenger vehicle VoT reflect wage rates in the OKI region*

*Source: United States Census (Op. Cit); United States Department of Transportation (Op. Cit.); SDG (2013); Brian Smalkoski and David Levinson (op. cit.).*

<sup>23</sup> Value of Time for Commercial Vehicle Operators, Brian Smalkoski and David Levinson, *The Transportation Research Forum* Vol 44, No 1 (2004).

### 5.3 TRAFFIC AND REVENUE FORECASTS

T&R forecasts were generated for an expanded 16-lane Brent Spence Bridge. Known as Alternative I, this assumed a base toll for transponder users of \$2, with a 50% premium for those using video payment. Light trucks face a toll of \$6 and heavy trucks \$10, and the video premium is also 50%.<sup>24</sup>

In an initial set of forecasts, traffic on the Brent Spence was estimated under the assumption that all users would pay for the toll using an electronic tolling mechanism. However, for both scenarios, the dual tolling technologies actually assumed combine electronic and video mechanisms, and transponder use in 2018 is assumed to be 50% for autos and 65% for trucks, converging to a constant rate of 70% and 85% after 10 years.

To account for the effect of payment mechanisms, the Project Team estimated diversion rates for both the base tolls (assuming transponder payment) and the toll under a 50% premium (assuming video payment) in the Toll Diversion Model and Sub-Area Model. The different diversion rates corresponding to each payment method were then applied to the shares of the Brent Spence users. The resulting model output demonstrated that gross revenues increased under this condition, because the additional revenue generated by the 50% video tolling premium more than offset the reduction in total usage arising from the additional charge and consequent toll diversion effects.

A 50% video premium was used for this analysis to take into consideration the additional costs of processing video transaction and help reduce toll violation risk, by encouraging customers to purchase transponders. This value is a sensitivity which will be evaluated in further detail during the development of future funding plans.

#### 5.3.1 FORECASTS/DIVERSION

**Table 5-3** details estimates of daily transactions under Alternative I. Daily transactions are over 116,600 in 2018, and at an annualizing factor of 325, total gross revenues through 2068 for Alternative I in constant \$2011 is \$9.9 billion. Note that the traffic figures account for the lower usage by those without transponders due to the 50% premium; the revenue figures, however, incorporate the additional revenue due to the 50% premium.

**Table 5-3: Alternative I Traffic and Revenue Forecasts**

COMMERCIAL VEHICLE VALUE OF TIME	2018	2025	2040
Daily Traffic (\$2/\$6/\$10 Tolls)	116,627	139,560	181,913
<b>Total Revenues, 2018-2068 (\$2011 millions)</b>	<b>\$9,883</b>		

*Note: The truck percentages associated with this traffic are 13% overall, with 4% light trucks and 9% heavy trucks.*

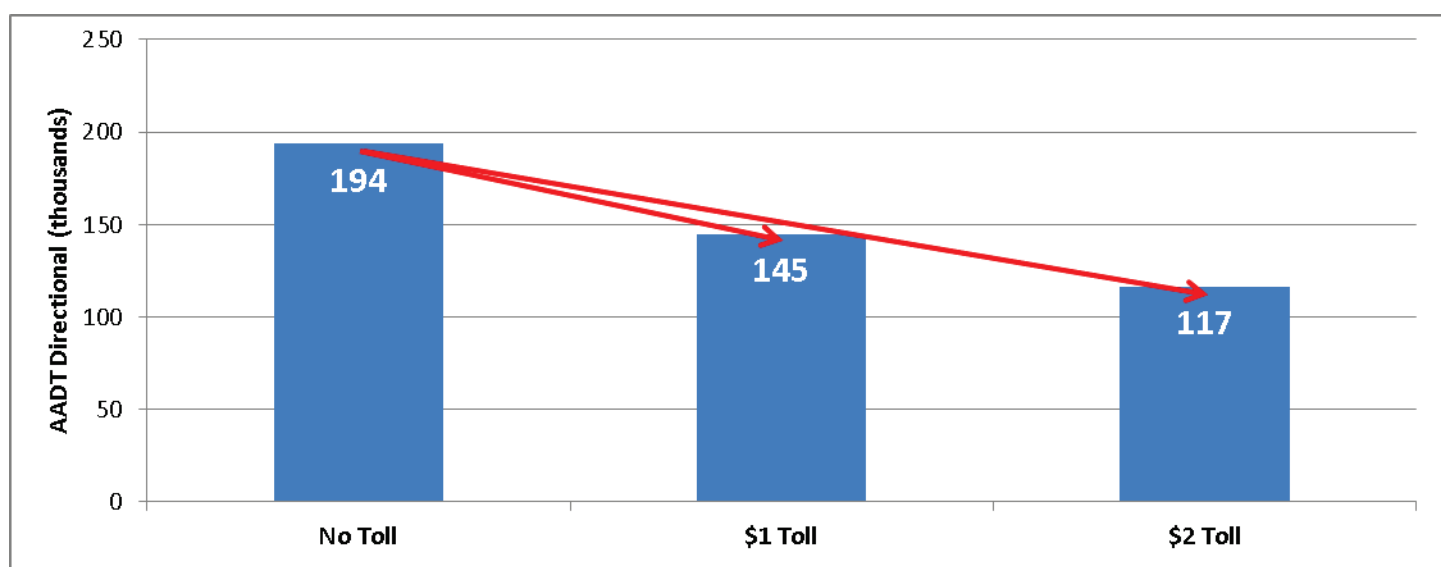
<sup>24</sup> Toll rates are presented in 2012 dollar terms.

An analysis of diversion following the imposition of tolls is of considerable interest. A large part of this diversion away from Brent Spence Bridge is absorbed by the Clay Wade Bailey Bridge and the Daniel Carter Beard Bridge. While in 2018, AADT on Brent Spence may be expected to decrease by 77,000 in response to the introduction of a \$2 toll, volumes on Clay Wade Bailey are expected to increase by 24,000 and on the Daniel Carter Beard Bridge by 25,000.

An alternative scenario using a \$1 toll, again with a 50% video premium, was also modeled. As expected, the lower toll would result in more traffic on the Brent Spence Bridge than under a \$2 toll: In 2018, assuming a \$1 toll there would be 145,000 daily vehicles using the facility (as compared to 117,000 for the \$2 toll). The diversion under this toll rate is 25%, and undiscounted revenues over the entire 50-year analysis period are forecast at \$6.05 billion.

**Figure 5-3** demonstrates the impact of tolling on the Brent Spence Bridge traffic - without a toll, the AADT is expected to be 194,000 in 2018. With a \$1 toll the AADT is expected to drop to 145,000, and with a \$2 toll the AADT is expected to drop to 117,000.

**Figure 5-3: 24-Hour Diversion Patterns for Alternative I in 2018**



The initial model runs - using a \$2 toll rate - are showing nearly 40% diversion in 2018. Diversion is lower during the peak periods when other routes may be more congested and higher during off peaks. More than 63% of diverted vehicles would choose as an alternative to use the Daniel Carter Beard Bridge and Clay Wade Bailey Bridge river crossings. Extending the analysis to 2040 reveals that diversion from the Brent Spence decreases markedly to 27%, as illustrated in **Figure 5-4**. This decrease in diversion over time is primarily reflects the impact of increased congestion on the network which makes the tolled, but less congested, Brent Spence more appealing.



Figure 5-4: Diversion Rates over Time (all Vehicles), \$1 and \$2 Base Toll

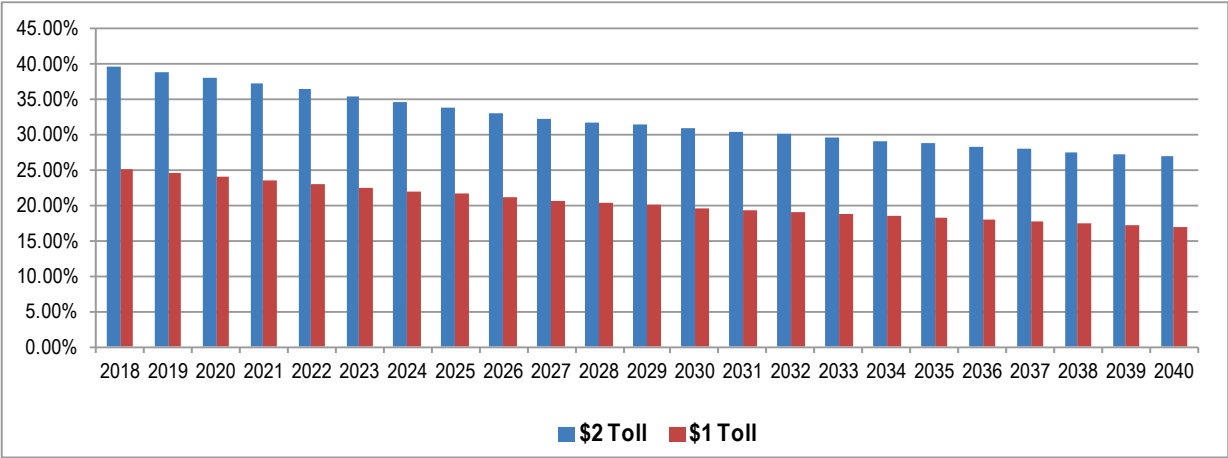


Figure 5-5: Diversion Patterns for Alternative I, \$2 Toll

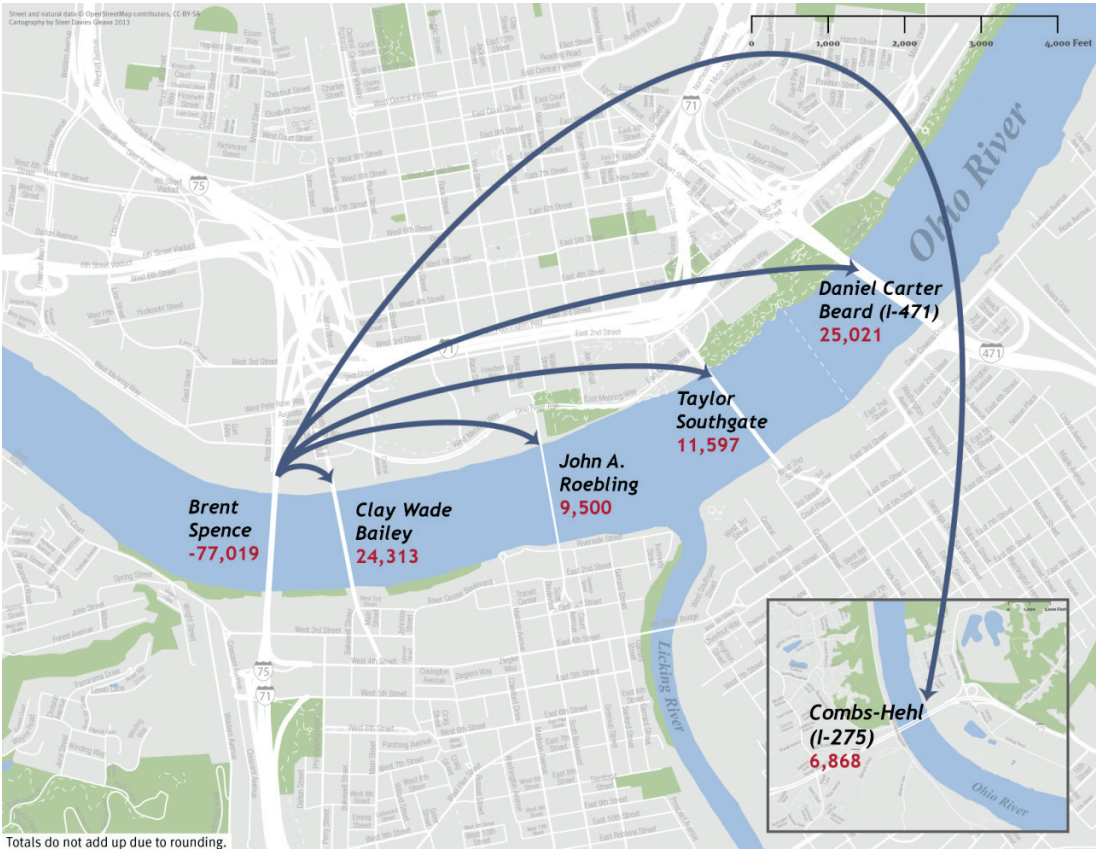




Table 5-4: Diversion Patterns from Brent Spence Bridge, 2018, \$2 Toll (All Vehicles)

CROSSING	24-HOUR RESULTS	AM PEAK	PM PEAK	OFF-PEAK
Brent Spence	-77,019	-11,418	-15,598	-50,002
Clay Wade Bailey	24,313	3,159	4,546	16,608
John A Roebling	9,500	1,123	1,837	6,541
Taylor-Southgate Central	11,597	2,443	2,351	6,803
Dan Carter Beard, I-471	25,021	3,990	4,664	16,368
Combs-Hehl, I-275	6,868	1,244	2,295	3,329

Table 5-5: Detailed Diversion Patterns from Brent Spence Bridge, 2018 \$2 Toll (All Vehicles)

	AM/NS	AM/SN	MD/NS	MD/SN	PM/NS	PM/SN	NT/NS	NT/SN
Brent Spence	-5,918	-5,500	- 13,344	- 17,186	- 8,178	-7,420	-8,449	-11,024
Clay Wade Bailey	898	2,261	2,067	7,743	3,086	1,460	1,364	5,434
John A Roebling	734	389	1,604	2,010	643	1,194	1,251	1,676
Taylor-Southgate Central	1,560	882	2,515	1,566	955	1,396	2,016	706
Dan Carter Beard, I-471	2,326	1,664	5,605	4,679	2,061	2,602	3,108	2,977
Combs-Hehl, I-275	670	573	1,155	789	1,480	815	932	453

Note: AM = AM peak period, PM = PM peak period, MD = midday period, NT=nighttime periods  
 NS = north to south and SN = south to north

Figure 5-6: Diversion Patterns for Alternative I, \$1 Toll

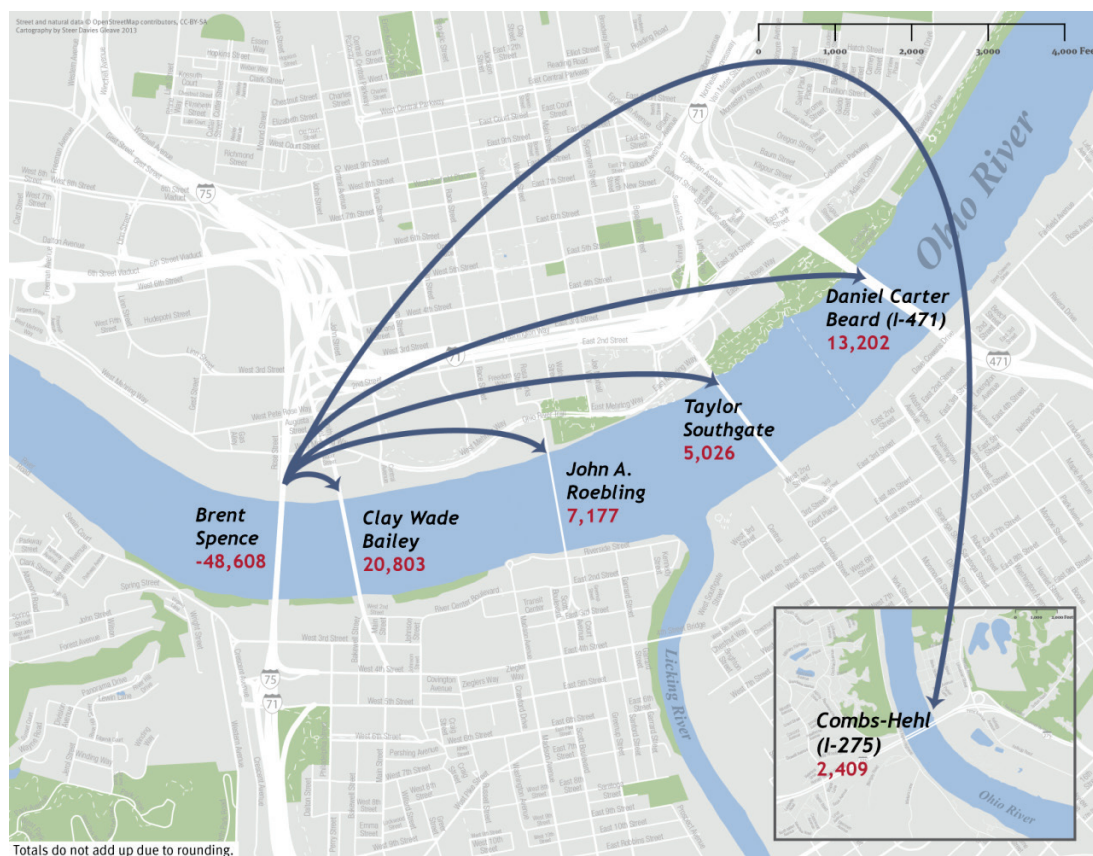


Table 5-6: Diversion Patterns from Brent Spence Bridge, 2018, \$1 Toll (All Vehicles)

CROSSING	24-HOUR RESULTS	AM PEAK	PM PEAK	OFF-PEAK
Brent Spence	- 48,608	- 6,863	- 9,141	- 32,604
Clay Wade Bailey	20,803	2,552	3,654	14,596
John A Roebling	7,177	823	1,420	4,934
Taylor-Southgate Central	5,026	1,180	960	2,886
Daniel Carter Beard, I-471	13,202	2,270	2,565	8,367
Combs-Hehl, I-275	2,409	450	750	1,208

**Table 5-7: Detailed Diversion Patterns from Brent Spence Bridge, 2018, \$1 Toll (All Vehicles)**

	AM/NS	AM/SN	MD/NS	MD/SN	PM/NS	PM/SN	NT/NS	NT/SN
Brent Spence	- 3,708	- 3,155	- 8,139	- 11,488	- 4,675	- 4,466	- 5,237	- 7,741
Clay Wade Bailey	791	1,761	1,736	6,845	2,455	1,200	1,173	4,843
John A Roebling	656	167	1,102	1,524	424	996	1,074	1,234
Taylor-Southgate Central	669	512	1,377	418	326	634	828	262
Daniel Carter Beard, I-471	1,524	746	3,255	2,159	1,067	1,498	1,756	1,197
Combs-Hehl, I-275	274	176	436	311	508	242	331	131

Note: AM = AM peak period, PM = PM peak period, MD = midday period, NT=nighttime periods  
 NS = north to south and SN = south to north

### 5.3.2 REVISED TRAFFIC AND REVENUE FORECASTS

The traffic and revenue forecasts reported here reflect the Project Team's re-calibrations to the existing model following initial results in December 2012 and January 2013. The modifications included:

- Increased capacity on non-interstate lanes surrounding the new Brent Spence Bridge from 1,200 vehicles per hour to 1,600 vehicles per hour (a 33.33% increase);
- Decreased capacity on the neighboring Roebling Bridge from 930 vehicles per lane per hour to 700 vehicles per lane per hour.
- Decreased VoT for light trucks of \$37 in 2013 dollars (see **Table 6-2**) to reflect updated estimates of factor costs.

Despite these changes, the net effect of the changes leave total undiscounted revenues essentially unchanged in the case of the \$2 scenario, as reported above.

## 6. RISK ANALYSIS

### 6.1 APPROACH TO RISK ANALYSIS

The value of risks for the DB Model and AP Model were quantified using a hybrid approach:

- Individually quantified risks: Specific quantified risks were identified and assigned to the owner (public sector) or contractor/concessionaire (private sector) during workshops that took place in January and March of 2013.
- Delivery model efficiency and innovation potential: During a May 2013 meeting KYTC and ODOT leaders agreed that there were significant potential innovation and efficiency savings associated with the DBFOM Model and these are represented in this Options Analysis by the addition of a minimum of 5% to the DB delivery alternative. This factor will be the subject of further assessment in future study phases and depends upon the extent to which the States are able to permit certain innovations within the design, construction, operations and maintenance specifications. For the purpose of this Options Analysis an upper range of 15% was applied to reflect a more aggressive approach to seeking innovation and efficiency savings through the DBFOM procurement process.

This section describes this hybrid approach in more detail.

### 6.2 INDIVIDUALLY QUANTIFIED RISKS

#### 6.2.1 DETERMINATION OF LIKELY COST IMPLICATIONS FOR EACH RISK

In January ODOT, KYTC, FHWA and the Project Team met to:

- Revisit the appropriateness of each risk established during a previous phase of the project
- Review additional risks not previously logged in the Risk Matrix;
- Assess the probability of each risk occurring; and
- Identify the likely financial consequence for the Project of each risk occurring.
- The above inputs were used to generate an assumed cost implication of each risk occurring. In the case of risks resulting in a schedule delay this schedule delay was converted to an associated monetary project impact value.

**Table 6-1** is a roll-up of the risks identified for inclusion in the Options Analysis. Risks have been broadly grouped by stages of Project development. The financial impacts are valued in PV dollars.

Table 6-1: Summary of Quantified Risks

RISK CATEGORY	DESCRIPTION	KEY REFERENCE DATA	FINANCIAL IMPACT PV (\$M) <sup>25</sup>
<b>Risks During Project Development</b>			
<b>Technical D&amp;C Risks:</b> Acquisition of ROW	Additional ROW requirements may be identified either by the States or a private party	<ul style="list-style-type: none"> <li>FHWA Cost Estimate Review</li> <li>Preliminary Risk Workshop</li> </ul>	9.9
<b>Technical D&amp;C Risks:</b> Utilities conflicts and utilities management	Contractor or a private partner may encounter utilities conflicts during delivery	<ul style="list-style-type: none"> <li>FHWA Cost Estimate Review</li> <li>Preliminary Risk Workshop</li> </ul>	1.3
<b>Total Risks During Project Development</b>			11.2
<b>Risks During Construction</b>			
<b>Planning and Permits Risks:</b> Construction issues associated with permits, approvals or stakeholder opposition	Issues with obtaining appropriate permits, as well as public and political opposition to the Project, or sections of the Project	<ul style="list-style-type: none"> <li>FHWA Cost Estimate Review</li> <li>Preliminary Risk Workshop</li> </ul>	10.0
<b>Technical D&amp;C and Environmental Risks:</b> Unanticipated conditions	Construction contractor or private partner may encounter unanticipated site conditions or geological conditions, or may discover additional rehabilitation is required for existing bridge structure	<ul style="list-style-type: none"> <li>FHWA Cost Estimate Review</li> <li>Preliminary Risk Workshop</li> </ul>	20.2
<b>Technical D&amp;C Risks:</b> Contract modifications	Design specifications are too prescriptive or contract specifications are modified by the design team, construction team or owner to address D&C or O&M issues	<ul style="list-style-type: none"> <li>Preliminary Risk Workshop</li> </ul>	116.0
<b>Technical D&amp;C Risks:</b> Contractor fails to deliver to specifications	Contractor fails to properly manage phasing, subcontractor or suppliers, contractor or Agency fails to perform adequate QA/QC	<ul style="list-style-type: none"> <li>FHWA Cost Estimate Review</li> <li>Preliminary Risk Workshop</li> </ul>	8.0

<sup>25</sup> For this analysis, a discount rate of 5% is used as a proxy for the States' long term cost of capital.

RISK CATEGORY	DESCRIPTION	KEY REFERENCE DATA	FINANCIAL IMPACT PV (\$M) <sup>25</sup>
<b>Technical D&amp;C Risks:</b> Major construction or marine accidents	Major accidents may occur during construction period, requiring extensive work and/or cleanup efforts	<ul style="list-style-type: none"> <li>FHWA Cost Estimate Review</li> <li>Preliminary Risk Workshop</li> </ul>	2.0
<b>Total Risks During Construction</b>			156.2
<b>Risks During Operations</b>			
<b>Technical O&amp;M Risks:</b> Major traffic accidents	Major accidents may occur during operations period, requiring extensive work and/or cleanup efforts	<ul style="list-style-type: none"> <li>FHWA Cost Estimate Review</li> <li>Preliminary Risk Workshop</li> </ul>	1.0
<b>Technical O&amp;M Risks:</b> Private parties do not carry out obligations to contract specifications	Latent defects during operations, contractors fail to maintain infrastructure to specifications, vague or conflicting specifications	<ul style="list-style-type: none"> <li>Preliminary Risk Workshop</li> </ul>	28.6
<b>Total Risks During Operations</b>			29.6
<b>Total Quantified Project Risks</b>			<b>197.0</b>

#### 6.2.1.1 Allocation of Identified Risks

**Table 6-2** aggregates the total net present value of risk associated with the Project and allocates this risk value to the public and private sectors for each delivery model. Under both models, the total value of risks associated with the Project is identical<sup>26</sup>; the allocation of risk between the public and private sectors will change depending on the delivery model.

<sup>26</sup>Consistent with the total presented in Table 6-1.

Table 6-2: Summary of Risk Allocation<sup>27</sup>

RISK CATEGORY	DB MODEL			AP MODEL		
ESTIMATED VALUE OF RISKS RETAINED OR TRANSFERRED	TOTAL RISK VALUE	PUBLIC SECTOR (\$M PV)	PRIVATE SECTOR (\$M PV)	TOTAL RISK VALUE	PUBLIC SECTOR (\$M PV)	PRIVATE SECTOR (\$M PV) <sup>28</sup>
Risks during Project Development	11.2	8.4	2.8	11.2	8.4	2.8
Risks during Construction	156.3	111.6	44.8	156.3	99.3	57.0
Risks during Operations & Maintenance	29.6	28.6	1.0	29.6	0.3	29.3
Total Allocated Risks	197.0	148.5	48.6	197.0	107.9	89.1

### 6.2.1.2 Other Adjustments

When comparing the DB delivery method with DBFOM, certain costs may arise in one alternative but not in the other. This section identifies inequalities between public sector and private sector capabilities and recommends a “competitive neutrality” adjustment such that a ‘like-for-like’ Options Analysis can be achieved.

Under the AP Model, private participants incur taxes and levies that the public sector does not incur in the DB Model. To the extent that the public sector does not bear these additional costs, an equivalent cost must be imputed into the DB Model. This approach is supported by the rationale that under the DB Model the public sector is forgoing State tax revenues, which represents an opportunity cost to the public sector. This foregone tax revenue must be considered as a reduction in cash inflows (or value) to the States as part of the Options Analysis.

Federal taxation impacts have been excluded from this analysis, since benefits of the Project are only accrued at the State level. Accordingly, no competitive neutrality adjustment has been made for federal taxes or levies.

In some circumstances, adjustments for competitive neutrality are required for disadvantages faced by the public sector involved in project delivery, such as the increased costs of regulation and compliance. For purposes of this Options Analysis, we consider these disadvantages immaterial, and these have not been quantified.

Table 6-3 summarizes the allocation of Other Adjustments for each delivery model.

<sup>27</sup>For this analysis, a discount rate of 5% is used as a proxy for the States’ long term cost of capital. Ranges of risk estimates are driven by the Construction Risk Premiums and the Operations and Lifecycle Risk Premiums noted above

<sup>28</sup>Items in this column are assumed to be priced into the private sector concessionaire’s bid.



Table 6-3: Summary of Allocation of Other Adjustments

ADJUSTMENT	DB MODEL			AP MODEL		
ESTIMATED VALUE OF RISKS RETAINED OR TRANSFERRED	TOTAL RISK VALUE	PUBLIC SECTOR (\$M PV)	PRIVATE SECTOR (\$M PV)	TOTAL RISK VALUE	PUBLIC SECTOR (\$M PV)	PRIVATE SECTOR (\$M PV) <sup>29</sup>
Total Adjustments <sup>30</sup>	45.7	45.7	–	81.4	–	81.4

Retained risks include all identified risks that will be retained by the State, that is, all risks that will not be transferred to the private sector as part of the Project. The risks and adjustments allocated to the public sector in **Table 6-2** and **Table 6-3** represent the quantum of risk the public sector will retain under each delivery model, summarized in **Table 6-4**.

Table 6-4: Summary of Retained Risks

RISK OR ADJUSTMENT	DB MODEL	AP MODEL
ESTIMATED VALUE	PUBLIC SECTOR RETAINED RISKS	PUBLIC SECTOR RETAINED RISKS
Total Identified Risks	148.5	107.9
Total Adjustments	45.7	–
Total Retained Risks	194.2	107.9

## 6.3 DELIVERY MODEL INNOVATION AND EFFICIENCY SAVINGS

### 6.3.1 DETERMINATION OF INNOVATION AND EFFICIENCY SAVINGS

When considering different delivery methods, evidence is being accumulated by State agencies having experience in procurement, design, construction, operation and maintenance that, for the right project, the private sector can deliver significant savings through innovations and efficiencies. Certain innovations and efficiencies are more strongly encouraged and more easily realized by those delivery methods that transfer greater risks and responsibilities to the private sector.

**Table 6-5** identifies some of the sources of these innovations and efficiencies, comparing the DB Model with the DBFOM Model. It is acknowledged that the potential to realize many construction stage innovations and efficiencies would be captured by the States' decision to use DB as the baseline model, noting that the integrated nature of DB, as compared to Design-Bid-Build (DBB), already facilitates significant private sector

<sup>29</sup>Items in this column are assumed to be priced into the private sector concessionaire's bid.

<sup>30</sup>Other Adjustments are allocated between the DB Model and AP Model, with Forgone State Income Taxes allocated to the DB Model and Bid Establishment Costs, SPV Costs, Insurance Costs allocated to the AP Model.



innovation at the design and construction stages. Consequently, this report considers only the incremental efficiency and innovation enhancements that are typically realized when comparing DB and DBFOM.

**Table 6-5: Comparison of Sources of Innovation and Efficiency**

FACTOR AFFECTING INNOVATION AND EFFICIENCY SAVING	DB	DBFOM
<b>Design and Construction</b> - Alternative Technical Concepts introduced by Proposers during procurement	The DB Model allows for an Alternative Technical Concept process that allows Proposers to seek Proposer-specific changes to the States' requirements that would enable value adding concepts. Under DB, such concepts may be acceptable provided they are not detrimental to quality, do not adversely affect risk to the States and there are no changes to Life Cycle costs and risk.	Under DBFOM, the procurement process often permits and encourages a wider range of Alternative Technical Concepts to be brought forward by Proposers than would have been possible under DB, including concepts that may alter Life Cycle cost and risk. For example one Proposer team may propose a structure that has different maintenance needs from another. An Alternative Concept with differing life cycle impacts is difficult to evaluate under DB, where a fair procurement process demands that all Proposers compete on identical life cycle assumptions. However, under DBFOM, where Proposers are responsible for 35 years of O&M costs, such concepts may be legitimately considered within the procurement process.



FACTOR AFFECTING INNOVATION AND EFFICIENCY SAVING	DB	DBFOM
<b>Design and Construction</b> - Approach to Performance versus prescriptive provisions for Design Requirements and Construction Specifications	All DB design requirements and construction specifications contain a balance of prescriptive and performance-based provisions. However, under DB the public owner needs to control aspects of design and construction that would impact rates of deterioration, maintenance and operating costs. For example, under DB, where the Public Owner will pay the cost of lamp replacement and lighting energy costs, there is no advantage in writing a performance specification that allows each Proposer to make the lifecycle trade-offs between initial cost, replacement frequency, reliability and other factors.	Within DBFOM procurement, specifications and design requirements may be drafted more widely (allowing greater use of performance and outcome based specifications) for certain elements, allowing Proposers to consider more options and use their experience of the operational performance of different solutions. This approach applies to elements where the successful Proposer will be fully responsible for the routine maintenance and replacement of the element at the end of its useful life. In addition to the lighting example provided opposite, other elements for which greater choice can be given to Proposers include the design of wearing course, joints and drainage treatment systems. Note that this relaxation of prescriptive specification does not apply to long-life structural elements that have to be handed back to the public owner with a specified residual life.
<b>Design and Construction</b> - methods of work and equipment	Under the DB form of contract, the project scope is typically drafted in a manner that allows some variation in structural form, subject to constraints (for major structures) on geometry and visual quality that are set forth in the RFP documents. This has resulted in well-documented, significant differences in proposal prices for Proposers bidding on an otherwise identical project.	The DBFOM model doesn't offer significant additional innovation and efficiency savings over and above DB from the aspect of facilitating the widest possible choice of construction method and form that will allow one Proposer to make maximum benefits from availability of particular construction equipment or materials.

In meetings conducted during February and May of 2013, ODOT, KYTC and the Project Team agreed that a Construction innovation and efficiency saving and an Operations and Lifecycle innovation and efficiency saving would be applicable to the DBFOM Model as part of the Options Analysis to reflect factors including those presented in **Table 6-5**. Rather than show these adjustments as net deductions from the DBFOM Model, it was decided to reflect the numbers in this Options Analysis as percentage additions (premiums) added to the DB Model. It was resolved, as a preliminary range, in advance of more detailed treatment in a later study phase, that these would be represented in this Options Analysis by the addition of a minimum of 5% of base

construction costs and 5% of base non-tolling operating costs to the DB delivery alternative. This factor will be the subject of further assessment in future study phases and depends upon the extent to which the States are able to permit certain innovations within the design, construction, operations and maintenance specifications. Greatest potential innovation and efficiency savings would be obtained by:

- Allowing a significant range of potential alternative technical concepts, recognizing the Developer's responsibility for many (but not all) lifecycle risks
- Obtaining an optimum balance between prescriptive and performance-based specifications
- Placing significant reliance on the contract payment and deduction mechanisms, coupled with operation and maintenance performance requirements to drive the behavior of the private entity

For the purpose of this Options Analysis an upper range of 15% was applied to reflect a more aggressive approach to seeking innovation and efficiency savings through the DBFOM procurement process. Addition of 15% of base construction costs, and 15% of Operations and Lifecycle non-tolling operating costs were considered, as summarized in **Table 6-6**.

It should be emphasized that these additions to account for innovation and efficiency are preliminary in nature, and further due diligence should be conducted on risk assumptions as the Project progresses.

**Table 6-6: Summary of Premium Added to DB Costs to account for Innovation and Efficiency Delta**

CATEGORY	DESCRIPTION	KEY REFERENCE DATA	FINANCIAL IMPACT PV (\$M) <sup>31</sup>
Construction Innovation and Efficiency	Savings that arise as a result of opportunities for the private sector to introduce innovations and efficiencies to the design and construction using a DBFOM Method as compared to DB Method (based on a range of 5-15% of base construction costs)	<ul style="list-style-type: none"> <li>• Market Data</li> <li>• Past Projects</li> <li>• Examples as noted in <b>Table 6-5</b></li> </ul>	105.0 - 315.0
Operations and Lifecycle Innovation and Efficiency	Savings that arise as a result of opportunities for the private sector to introduce innovations and efficiencies to the operations and maintenance using a DBFOM Method as compared to the State' operations and maintenance obligations under DB Method (based on a range of 5-15% of base non-tolling operating costs)	<ul style="list-style-type: none"> <li>• Market Data</li> <li>• Past Projects</li> <li>• Examples as noted in <b>Table 6-5</b></li> </ul>	11.5 - 34.5
Total Adjustment For Innovation and Efficiency			116.5 - 349.5

<sup>31</sup>For this analysis, a discount rate of 5% is used as a proxy for the States' long term cost of capital.

As further evidence supporting the use of innovation and efficiency savings associated with DBFOM, the Project Team drew upon documented evidence from recent projects and procurements with characteristics similar to the Project, as well as relevant research publications<sup>32</sup>. The evidence from published research is that both DB and DBFOM delivery models provide greater budget certainty than traditional methods such as Design-Bid-Build, with DBFOM providing budget certainty over a longer time frame.

## 6.4 UNDERLYING ASSUMPTIONS

The results presented above are subject to the limitations and qualifications provided below and are to be considered within the context of this Options Analysis. Further, when using or quoting the above information, it is important to remember that the risk costs shown are high level estimates based on the information available at the time of this assessment. As such, the estimated costs shown here are subject to change depending on the availability of additional information and refinement of key inputs and assumptions.

Given the early stage of the Project and the high level of cost estimates available to date, various assumptions have been made as part of the Options Analysis, which are as follows.

- It is recommended that a more sophisticated risk analysis is undertaken at a later stage of the procurement process, once the Project and its associated risks are better understood and better defined.
- The risks included in the Risk Matrix are high level risks, and not all detailed Project risks have been identified.
- This analysis has used the cost schedule to inform risk. In reality, risks are discrete independent events not related to the cost of the Project or stages within it.
- This analysis uses expected values to inform the totals in the above summary. These numbers may underestimate a prudent contingency level.

<sup>32</sup>The Project Team consulted sources including, but not limited to: U.S. Government Accountability Office (GAO/RCED-97-47), Managing the Costs of Large-Dollar Highway Projects (February 1997); U.S. Government Accountability Office (GAO-03-764T), Cost and Oversight of Major Highway and Bridge Projects - Issues and Options (May 2003); U.S. Department of Transportation, Report to Congress on Public-Private Partnerships (December 2004); Chasey, A.D. et al (Arizona State University), A Comparison of P3's, DB and DBB Project Delivery Methods in North American Highway Construction (July 2012).

## 7. PRELIMINARY QUANTITATIVE ANALYSIS

### 7.1 OVERVIEW

This section covers the preliminary quantitative results of the Options Analysis conducted by the Project Team. The quantitative analysis is the culmination of the analysis performed in Sections 4, 5 and 6.

For each delivery model, Project risks were identified, quantified, and allocated between the public and private partners. After allocating risks, a set of financial models were created to capture costs and revenues for each delivery model. These inputs are summarized in **Table 7-1**.

All outputs have been considered as present values over a common term. The analysis primarily focuses on three parameters, namely:

- Level of public funds or subsidy, generally required to address Project funding shortfalls or cash flow coverage breaches;
- Amount of net excess cash flows generated after servicing all contractual obligations of the Project;
- Net Project value or net Project cost, determined with reference to all Project development costs, base construction costs, financing costs and retained risks associated with the Project.

These results are based in a specific period of time, and are based on preliminary Project inputs. It is recommended that further quantitative analysis and due diligence be undertaken throughout the entire procurement process, as the Project evolves and as key inputs for traffic, revenues, costs and financing are refined.

The results discussed herein are presented on the basis of the \$2 tolling scenario. Additionally, all delivery models are assumed to be able to obtain a federal TIFIA Loan to help finance the Project. This is a very significant assumption, since the availability of TIFIA will provide far greater leverage of forecasted cash flows, and significantly greater transfer of financial risk at relatively low interest rates, than available through the private financing markets. Such financing has tended to provide greater benefit to the DB Model relative to the AP Model, since under the AP model private equity would be a reasonable substitute, albeit at a significantly increased capital cost, for a TIFIA Loan. Such a substitute does not generally exist in the tax-exempt markets applicable to the DB Model, and therefore the TIFIA Loan is a key underpinning of the finance plan.

Table 7-1: Summary of Key Inputs for DB and AP Models<sup>33</sup>

INPUT OR ASSUMPTION	DB MODEL	AP MODEL	
	PV (\$M)	PV (\$M) DURING 5+35-YEAR AP TERM	PV (\$M) AFTER 5+35-YEAR AP TERM
Revenues (\$2 tolling scenario)	5,241	3,951	1,289
Construction Costs <sup>34</sup>	(2,205)	(2,173)	–
Operations and Maintenance Costs <sup>35</sup>	(90)	(74)	(18)
Tolling Operations Costs (\$2 tolling scenario)	(449)	(338)	(111)
Lifecycle Costs	(240)	(139)	(102)
Retained Risk Adjustments	(194)	(108)	–

<sup>33</sup>Note: Table 7-1 provides the present value of inflated revenue figures starting with revenues anticipated for 2019. For this analysis, a discount rate of 5% is used. This number is a proxy for the States' long term cost of capital in the current tax-exempt markets.

<sup>34</sup>Construction Costs for the AP Model are adjusted from base construction costs because they include SPV and Insurance Costs during Construction. Construction costs for the DB Model are adjusted from base construction costs because they include Risk Premiums as included in Table 7.1 (\$105 million).

<sup>35</sup>Operations and Maintenance Costs for the AP Model (when considering total costs both during and after the AP term) are adjusted because they include SPV Costs during Operations. Operations and Maintenance Costs for the DB Model are adjusted because they include Risk Premiums as included in table 7.1 (\$11.5 million).

## 8. SUMMARY OF FINDINGS

### 8.1 QUANTITATIVE RESULTS

#### 8.1.1 DB MODEL

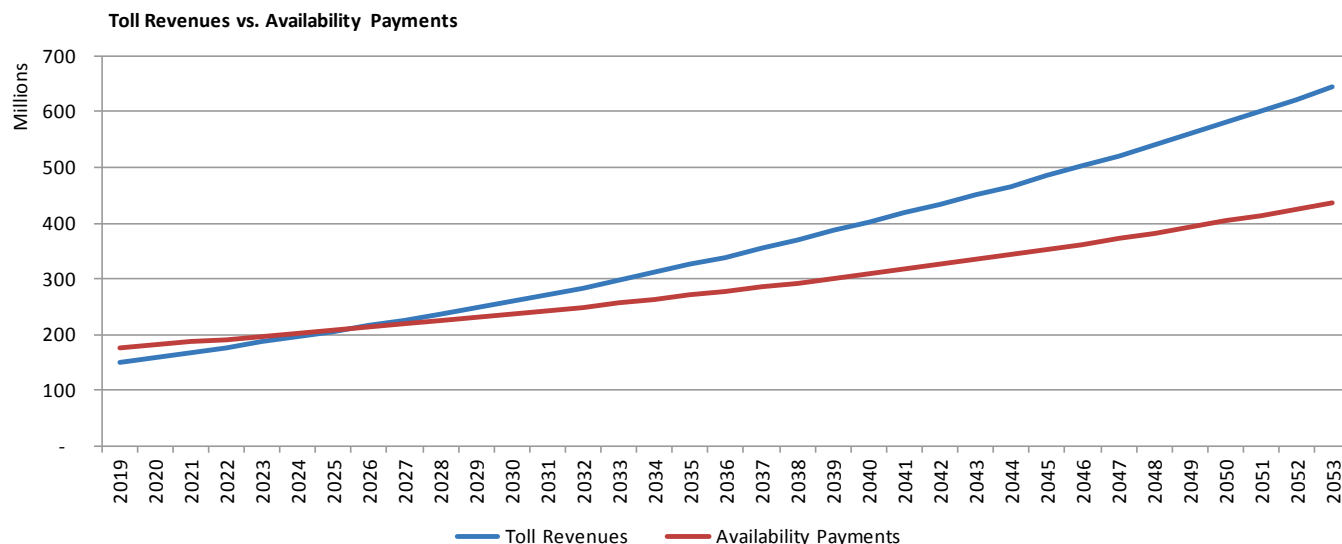
The DB Model analysis assumed a five-year construction period, under a single DB project delivery contract. Following construction completion in 2018, a 50-year operations period is assumed to begin in January 2019, resulting in a total 55-year evaluation period. The DB Model assumes public financing mechanisms as discussed in **4.2.2**, most notably toll revenue bonds and TIFIA, in order to fund estimated upfront Project costs.

The estimated upfront Project costs are between \$253 million and \$576 million (in PV terms) of public subsidy to support the upfront construction costs of the Project. After consideration of all revenues, costs and risks associated with the DB Model, a net Project value of between \$123 million and (\$85) million (in PV terms) is estimated to accrue to the States, as illustrated in In order to receive this longer term benefit, the States would need to identify the source of funds for the up-front net subsidy during the construction period. A detailed breakdown of net Project value is provided in **Table 8.1**.

#### 8.1.2 AP MODEL

The analysis of the AP Model assumes a five-year construction period followed by a 35-year operating and maintenance period, for a total 40-year concession period. To provide a comparable-period assessment with the DB Model, the Options Analysis also takes into account the 15 years of net cash flows forecasted subsequent to the concession period, based on forecasted revenues, operations and maintenance costs and lifecycle costs during that time frame.

The AP Model assumes both private and federal financing mechanisms as discussed in **4.2.2**, most notably equity, tax-exempt Private Activity Bonds and TIFIA, in order to fund estimated upfront Project costs. The AP Model delivers a net excess cash flow during the concession period of between \$617 million and \$672 million (in PV terms). Once Availability Payments cease in 2053, any net cash flows from operations accrue to the benefit of the States.

**Figure 8-1: Relationship between Availability Payments and Forecast Toll Revenue (in \$millions)**

As seen above, Availability Payments exceed net toll revenues in the short-term; however, forecast toll revenues exceed Availability Payments for most of the Project's duration. As a whole, a public subsidy of \$0 to \$40.0M is required under the AP model to cover these toll shortfalls, assuming they are not financed back into the AP model. On a net present value basis, toll revenues from the Project are sufficient to fund Availability Payments over the analysis horizon. After consideration of all revenues, costs and risks associated with the AP Model, a net Project value of \$257 million and \$312 million (in PV terms) is estimated to accrue to the States. However, the shortfall between Availability Payments and net toll revenues will need to be funded in the short-term, potentially through public funds, public debt or short-term toll increases.

The amount of public contribution/subsidy required for each delivery model is characterized by the timing - namely during the construction period or the operating period. The timing requirement is a function of the delivery model selected. For the DB Model, the public contribution represents the amount of additional funding required to complete the construction and meet the financial covenants. For the AP Model, the amount of public contribution represents the difference between forecast operational revenues and the Availability Payments that commence upon completion of the Project.

### 8.1.3 THE IMPACT OF TIFIA

The Options Analysis outputs presented in **Table 8-1** illustrate the quantitative outcomes of each delivery model where a TIFIA Loan is secured in all cases.



**Table 8-1: Summary of Key Outputs for DB Model and AP Model<sup>36</sup>**

ASSUMPTION	DB MODEL	AP MODEL
	PV (\$M)	PV (\$M)
Public Contribution/Subsidy (Construction)	(576) - (253)	-
Public Contribution/Subsidy (Operations)	-	0-(40)
Net Toll Revenues less APs <sup>37</sup>	-	617-672
Excess Cash Flow After AP Concession Term	-	258
Excess Cash Flow After Debt Service	1,080 - 1,195	-
Retained Risks <sup>38</sup>	(194)	(108)
ROW <sup>39</sup>	(61)	(61)
Tolling Operations Costs	(449)	(449)
<b>Net Project Values/(Costs)</b>	<b>(85) - 123</b>	<b>257-312</b>

In order to fund upfront construction costs, the Options Analysis estimates that public funding contributions of between \$253 million and \$576 million (in PV terms) will be required for the DB Model. A source for these contributions will need to be identified. As noted earlier, it may be possible in the AP Model to finance shortfall that exists during operations through a structured Availability Payment, and as such, a range of operational subsidy is shown.

The value ranges shown in **Table 8-1** for certain items of the DB Model have been developed on the basis of various input assumptions specific to the DB Model, namely:

- Variations in coverage, ranging from 2.25x (aggressive) to 2.75x (conservative), as discussed in **5.1.4**; and

<sup>36</sup>For this analysis, a discount rate of 5% is used as a proxy for the States' long term cost of capital.

<sup>37</sup>Includes operational subsidy.

<sup>38</sup>Retained risk is considered 'below the line', that is, they are risks that are retained by the States and not required to be funded as part of the Project or the developer's financing solution.

<sup>39</sup>ROW costs are considered 'below the line', that is, they are risks that are retained by the States and not required to be funded as part of the Project or the developer's financing solution.

- Variations in assumed premiums associated with innovations and efficiencies, ranging from 5% to 15%, as discussed in **6.3.1**.

However, it should be emphasized that these findings should not be treated as conclusive outcomes, and that they are dependent on the following points.

- **The availability of TIFIA.** The findings above have been presented on the basis that TIFIA assistance will be made available to the Project. If TIFIA funding is not likely to materialize, then consequential revisions to financing solutions will impact the findings presented in this Options Analysis. Note that significant nationwide competition currently exists for allocations of credit assistance under the TIFIA program, and that no precedent currently exists for a project commitment of this magnitude. Reductions in the amount of TIFIA assistance will have a negative impact on the net project value results.
- **Alternative tolling scenarios.** The findings above have been presented on the basis that a \$2 toll, with a 50% video collection premium, is applied. Financial outcomes will vary if a \$1 toll, or a fixed video premium, is applied.
- **Qualitative considerations.** Qualitative considerations may significantly impact identification of a preferred delivery model. The States should not be guided solely by the financial outcomes of this analysis, but should also consider the full range of qualitative issues before settling on a preferred delivery model. Qualitative considerations are discussed further in **Section 8.1.5**.

**Table 8-2** shows the quantitative outputs in the scenario where the States are not successful in securing a TIFIA Loan in the amount required under each of the delivery models. Key points are outlined below.

- The net Project value of the DB Model reduces relative to the AP Model, as in this case the public sector replaces TIFIA with sub-investment grade subordinate debt, if available in the market, to fund its Project obligations.
- The non-TIFIA AP Model reduces its net cash flow relative to toll revenues received earlier in the Project analysis horizon, driving a reduced net Project value. Additional investment grade senior lien debt and/or equity may partially replace the lost TIFIA allocation.
- As noted above, there is significant nationwide competition that currently exists for allocations of credit assistance under the TIFIA program, and no precedent currently exists for a project commitment of this magnitude. Reductions in the amount of TIFIA assistance will have a negative impact on the net project value results.
- The amount of public contribution required under the AP Model is in the range of \$91 million to \$191 million (in PV terms), given that it may be possible to finance a portion of this shortfall that exists during operations through a structured Availability Payment.

**Table 8-2: Summary of Key Outputs (without TIFIA) for DB and AP Models<sup>40</sup>**

INPUT OR ASSUMPTION	DB MODEL	AP MODEL
	PV (\$M)	PV (\$M)
Public Contribution/Subsidy (Construction)	(1,450) - (1,041)	-
Public Contribution/Subsidy (Operations)	-	(91)-(191)
Net Toll Revenues less APs <sup>41</sup>	-	0-191
Excess Cash Flow After AP Concession Term	-	258
Excess Cash Flow After Debt Service	1,513 - 1,370	-
Retained Risks <sup>42</sup>	(194)	(108)
ROW <sup>43</sup>	(61)	(61)
Tolling Operations Costs	(449)	(449)
<b>Net Project Values/(Costs)</b>	<b>(641) - (375)</b>	<b>(360)-(169)</b>

#### 8.1.4 THE IMPACT OF TOLLING

The Options Analysis outputs presented in **Table 8-1** and **Table 8-2** illustrate the net Project values/costs of each delivery model when a \$2 tolling level is applied in all cases. **Table 8-3** shows the quantitative outputs if a \$1 tolling level is applied, with TIFIA assistance. Key points are outlined below.

- The reduction of tolling from the \$2 tolling scenario to the \$1 tolling scenario significantly reduces the Project's net value, under both the DB and AP Models.
- Under the DB Model, the level of public subsidy required to support the Project is between \$685 million and \$950 million.

<sup>40</sup>For this analysis, a discount rate of 5% is used as a proxy for the States' long term cost of capital.

<sup>41</sup>Includes operational subsidy.

<sup>42</sup>Retained risk is considered 'below the line', that is, they are risks that are retained by the States and not required to be funded as part of the Project or the developer's financing solution.

<sup>43</sup>ROW costs are considered 'below the line', that is, they are risks that are retained by the States and not required to be funded as part of the Project or the developer's financing solution.

**Table 8-3: Summary of Key Outputs (with \$1 tolls, with TIFIA) for DB Model and AP Model<sup>44</sup>**

INPUT OR ASSUMPTION	DB MODEL	AP MODEL
	PV (\$M)	PV (\$M)
Public Contribution/Subsidy (Construction)	(950) - (685)	-
Public Contribution/Subsidy (Operations)	-	(814)
Net Toll Revenues less APs <sup>45</sup>	-	(804)
Excess Cash Flow After AP Concession Term	-	146
Excess Cash Flow After Debt Service	556 - 619	-
Retained Risks <sup>46</sup>	(194)	(108)
ROW <sup>47</sup>	(61)	(61)
Tolling Operations Costs	(449)	(449)
<b>Net Project Values/(Costs)</b>	<b>(1,035) - (833)</b>	<b>(1,276)</b>

The net project value for the DB Model in the \$1 toll scenario assumes that a public subsidy is contributed during the construction period to facilitate the Project's delivery alongside the toll revenue bonds. Once construction is completed, the analysis assumes that cash flows after debt service and other obligations are for the benefit of the States. This cash flow turns positive early in the evaluation horizon.

Conversely, under the Availability Payment scenario with \$1 tolls, the analysis assumes that the full cost of the Project is financed by the developer and repaid by an Availability Payment. In the short-term, cash flow after the payment of Availability Payments and other obligations is negative. Funding will be required to cover this shortfall between Availability Payments and net toll revenues, which may be provided through public funds, public debt or short-term toll increases.

The difference in timing of positive cash flow under the DB Model to negative cash flow under the alternative delivery model drives the difference in net Project value. In this tolling scenario, the level of public contribution required during operations is unlikely to be financed through a structured Availability Payment

<sup>44</sup>For this analysis, a discount rate of 5% is used as a proxy for the States' long term cost of capital.

<sup>45</sup>Includes operational subsidy.

<sup>46</sup>Retained risk is considered 'below the line', that is, they are risks that are retained by the States and not required to be funded as part of the Project or the developer's financing solution.

<sup>47</sup>ROW costs are considered 'below the line', that is, they are risks that are retained by the States and not required to be funded as part of the Project or the developer's financing solution.

over the AP Model concession term due to the overall Project revenues relative to the shortfall between AP and Project revenues. A range of public contribution during operations has not therefore been shown.

### 8.1.5 QUALITATIVE CONSIDERATIONS

It is important to consider the financial outcomes of the Options Analysis in the context of the Project and its sponsors. Although the quantitative analysis presented above may offer some insight into the feasibility of each delivery model, financial output alone should not dictate the selection of a preferred delivery model. The States should be mindful of the “non-financial” qualitative factors that are equally important to the selection of a preferred delivery model. These considerations, which will be further explored during the next phase of the study, should include:

- **Experience of similar project delivery** – the States’ experiences with procuring and implementing specific delivery models for projects of similar scale and estimated cost to the Project is unprecedented and alignment of the goals of each State with the relative benefits of different delivery methods will be a key consideration;
- **Community and stakeholder positions on project related issues** – level of support or resistance from third parties (community groups, cities, businesses, residents, etc.) and how this plays out in the media and influences the States’ ability to move forward should be more fully explored;
- **Procurement leadership** – the identification of senior leadership to drive the project and the availability of State staff or resources to procure and deliver the various contract options;
- **Expected private sector interest and participation** – the level of interest, under the right conditions, should drive an effective competition and help deliver value to the states;
- **Economic impact** – the benefit the region receives due to the improvement to this commerce corridor in comparison to the cost to the region of delaying transportation infrastructure improvement;
- **Scope Change Flexibility** – the ease with which desired changes to the scope can be carried out and the relative cost of doing so at various points in the process;
- **Budget Certainty** – the ability to be confident of the cost to owning, operating and maintaining the infrastructure during the analysis period;
- **Opportunity for innovation, cost reduction and/or risk transfer** – to varying degrees each delivery model may provide different opportunities to drive long-term value to the States and should be assessed;
- **Contract structure** – the relative complexity for each delivery method could impact the States’ and industry’s ability to successfully implement the contracts;
- **Federal commitments and interactions** – The ability to secure requisite project approvals from the federal government, including the ability to secure an unprecedented level of TIFIA assistance, are key considerations to the evaluation of delivery alternatives.
- **States’ legislative, legal and policy frameworks** – Table 8-4 summarizes what additional authority is required by each state to move forward with the Project.

Table 8-4: Summary of States' Authorities

LEGISLATION	PURPOSE	KY	OH
<b>Tolling authority</b>	To allow the Project to be tolled.	Amendment needed to KRS 175B to include projects between Kentucky and Ohio.	Existing authority as part of: O.R.C. 5531.11 – 5531.99 (Toll facilities) O.R.C. 5501.70 – 5501.73 (P3 Facility)
<b>Toll violation enforcement</b>	For electronic tolling to be implemented	Amendment needed to KRS 175B to include projects between Kentucky and Ohio.	Authority needed as part of: O.R.C. 5531.15 (Toll facilities, amendment needed for video enforcement) O.R.C. 5501.77 (User fees on P3 facilities, amendment needed for video enforcement)
<b>DB authority</b>	For DB jobs over a certain dollar value	Current authority exists for up to 5 design build projects with a construction value of \$30M or less.	Existing authority as part of O.R.C. 5517.011, but currently capped at \$1 billion per fiscal year.
<b>P3 authority</b>	For state to procure P3 services	Amendment needed to KRS 175B to allow P3 option.	Existing authority as part of O.R.C. 5501.70 – 5501.80.

- **Federal Credit Assistance** – the impact that each delivery method could have on securing TIFIA credit assistance in a timely fashion, and in the amount estimated;
- **States' support and/or credit backstop** – the viability of securing and reliance on the relevant support from the States;
- **Whole life performance standards** – the degree to which States define requirements as whole life performance requirements will drive long-term value. How comfortable the states are doing this and how they enforce the standards are also consideration;
- **Operational Control** – the level of control the states maintain over the facility
- **Implementation of tolling** – the anticipated tolling approach, administration, policy (such as toll collection and rate setting) and back office operations will influence anticipated level of transaction and revenue and therefore the financial viability of each delivery model;
- **Toll revenue surpluses** – the potential for the extent to which the States share any toll revenue surpluses impacts the overall net project value and financial viability;
- **Decision making process** – the ability and speed that each State, or a board that has authority to act on behalf of the States, would have to make project and contract decisions should be explored and understood relative to each delivery model.

## 9. KEY FINDINGS AND NEXT STEPS

### 9.1 SUMMARY OF KEY FINDINGS

The findings from the Options Analysis are based on preliminary Project inputs, which provide a range of outputs for both delivery models. Presently, these outputs are indicative, but lack sufficient precision to draw a conclusion regarding the best value approach to delivering the Project. As discussed in **Section 8**, further due diligence and refinement of cost inputs is expected to be performed in the next phase. The net Project values/costs of the preliminary analysis are summarized in **Table 9-1** and display both Conservative and Aggressive assumptions for the DB Model.

**Table 9-1: Summary of Net Project Values/Costs for each Delivery Model<sup>48</sup>**

MODEL	\$1 TOLL (\$M PV)				\$2 TOLL (\$M PV)			
	TIFIA		NO TIFIA		TIFIA		NO TIFIA	
	5% PREMIUM	15% PREMIUM	5% PREMIUM	15% PREMIUM	5% PREMIUM	15% PREMIUM	5% PREMIUM	15% PREMIUM
DB Model <sup>49</sup>	(858)	(1,035)	(1,390)	(1,610)	88	(85)	(421)	(641)
DB Model <sup>50</sup>	(833)	(1,009)	(1,356)	(1,577)	123	(45)	(375)	(591)
	TIFIA		No TIFIA		TIFIA		No TIFIA	
AP Model	(1,276)		(1,757)		257-312		(360)-(169)	

Public funding amounts are detailed in **Table 9-2**.

<sup>48</sup> For this analysis, a discount rate of 5% is used as a proxy for the States' long term cost of capital.

<sup>49</sup> Conservative financing assumptions (see chapter 8)

<sup>50</sup> Aggressive financing assumptions (see chapter 8)

Table 9-2: Summary of Public Funding Required for each Delivery Model<sup>51</sup>

MODEL	\$1 TOLL (\$M PV)				\$2 TOLL (\$M PV)			
	TIFIA		NO TIFIA		TIFIA		NO TIFIA	
	5% PREMIUM	15% PREMIUM	5% PREMIUM	15% PREMIUM	5% PREMIUM	15% PREMIUM	5% PREMIUM	15% PREMIUM
DB Model (construction period) <sup>52</sup>	780	950	1,587	1,796	438	576	1,241	1,450
DB Model (construction period) <sup>53</sup>	685	841	1,455	1,665	253	386	1,041	1,247
	TIFIA		No TIFIA		TIFIA		No TIFIA	
AP Model (operating period)	814		1,301		0-40		91- 191	

## 9.2 POTENTIAL NEXT STEPS

At this time, the steps to advance the Brent Spence Project should include:

- Further consideration of qualitative issues of relevance within each State;
- Development of a more robust bi-State governance and Project oversight agreement;
- Initiation of a federal strategy to position the Project for key federal approvals, including environmental, tolling, TIFIA and other funding/financing issues;
- Consideration of project phasing and/or segmentation relative to each delivery model;
- Advancement of the environmental process/documentation effort, which is currently on the critical path;
- Development of more detailed schedule, funding and delivery model estimates for both the Design-Build and Availability Payment Concession delivery options;
- Further assessment of commercial structure alternatives;
- Initiation of toll concept and a schedule of alternative tolling/operating models;
- Refinement of Project inputs, including those inputs related to traffic, revenue, costs and financing;

<sup>51</sup> For this analysis, a discount rate of 5% is used as a proxy for the States' long term cost of capital.

<sup>52</sup> Conservative financing assumptions (see chapter 8)

<sup>53</sup> Aggressive financing assumptions (see chapter 8)



- Further due diligence and potential refinements to the risk assumptions and innovation/efficiency savings under each delivery model;
- Continued public outreach and education of stakeholders; and
- Development of an approach to identifying and securing necessary state legislation.